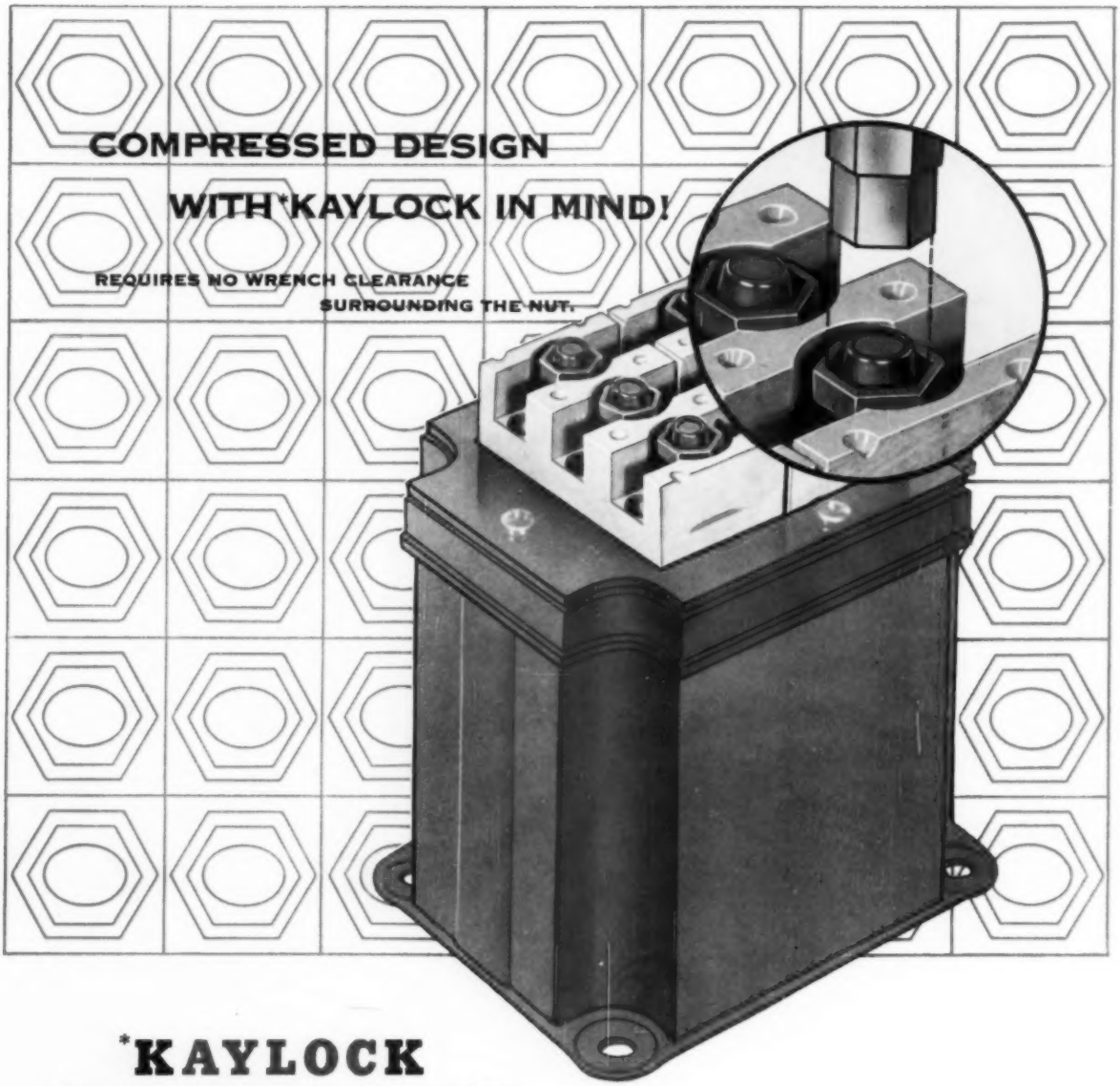
MARCH 3, 1958

Aviation Week

25th ANNUAL INVENTORY OF AIRPOWER

COMPRESSED DESIGN WITH *KAYLOCK IN MIND!

REQUIRES NO WRENCH CLEARANCE SURROUNDING THE NUT.



*KAYLOCK

all-metal self-locking INTERNAL/external wrenching lightweight aircraft Hex Nuts

40% space savings were accomplished by placing the terminal posts more closely together—by using Kaylock INTERNAL/external wrenching Hex Nuts.

Another successful miniaturization job—made possible by using the internal wrenching feature of Kaylock Hex Nuts. Kaylock's patented all-metal design gives maximum fastening strength with minimum size and weight!

DESIGNERS:
When you're in a "tight spot" for fastening and wrenching, *base your design on Kaylock INTERNAL/external wrenching Hex Nuts.*

- Save material, space and weight: Put *more* fastenings & connections into *smaller* areas.
- Reduce material damage: Internal wrenching gives maximum protection to surrounding surfaces.

Kaylock Hex Nuts conform to all three Air Force-Navy standards: AN363, AN364, AN365, and the new low height National Aircraft Standard NAS679.

Complete line of Kaylock all-metal self-locking nuts available in steel or A-286 corrosion-resistant steel for use to 1200°F.

Setting Standards of Progress

Trade Mark

KAYNAR MFG. CO. INC.—KAYLOCK DIVISION • Dept. LG, BOX 2001, TERMINAL ANNEX, LOS ANGELES 54, CALIF.
Canadian Distributor: Abercorn Aero Ltd., Montreal, Quebec

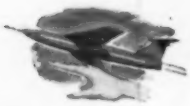
Circle Number 65 on Reader-Service Card

What does it take to create a complete

Missile Weapon System?

WEAPON SYSTEM: A definition

"A system composed of equipment, skills and techniques, the composite of which forms an instrument of combat, usually . . . having an air vehicle as its major operational element. The complete weapon system includes all related equipment, materials, services, and personnel required solely for the operation of the air vehicle . . . so that the instrument of combat becomes a self-sufficient unit of striking power within its intended operational environment."
— Quoted from Defense Department Regulations

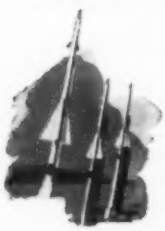


GUIDANCE
— of the accuracy of ATRAN. Goodyear Aircraft Corporation designed, developed and produces this system for guiding American missiles.

RADOMES
— exterior structural plastic housing for a missile's electronic eyes. Goodyear Aircraft is a pioneer and leading producer of such housings.

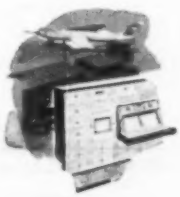
RADAR
— Goodyear Aircraft builds hi-performance airborne systems and large radar structures for early warning, missile guidance and tracking systems.

AIRFRAMES
— fabricated of the newest alloys by the most advanced techniques. Goodyear Aircraft has decades of light-metals experience in airship pioneering, building thousands of complete airplanes and structures for today's jet aircraft and missiles.



ROCKETS
—to propel the missiles skyward. Goodyear Aircraft builds more large-size rocket cases than any other manufacturer, has one of the largest facilities in the nation.

GROUND SUPPORT EQUIPMENT
— to check the missile's design characteristics, the complete system's performance—to move, maintain, launch a squadron's missiles. Goodyear Aircraft designs and builds this equipment, and has created today's foremost mobile missile ground support system.



COMPUTERS AND FLIGHT SIMULATORS
— to check the missile's initial design characteristics and simulate its flight. Goodyear Aircraft builds GEDA, an analog computer, and supplies flight simulators for the military services.

UNIFIED ENGINEERING
— to solve the technical complexities of creating a complete system. Goodyear Aircraft has a Weapon System Engineering organization—specialists with a unified approach to, and complete familiarity with, the total problem.

PRODUCTION FACILITIES
— to tie together and produce the whole concept. Goodyear Aircraft maintains facilities in Akron, Ohio, and Litchfield Park, Arizona, where 12,000 skilled people work—*To Keep America First In The Air.*

GOODYEAR AIRCRAFT

Plants in Akron, Ohio, and Litchfield Park, Arizona.

ATRAN, GEDA – T. M.'s Goodyear Aircraft Corporation, Akron 15, Ohio

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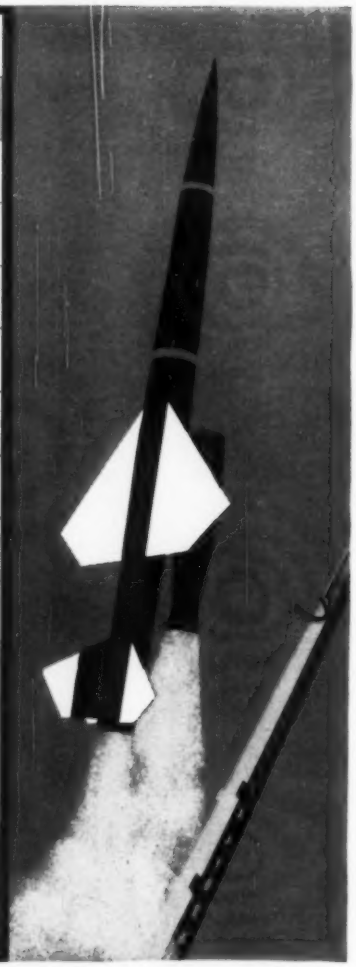

Looking for solutions?

AMF has missile experience you can use

• Building a reliable missile system introduces problems at every step . . . the kind AMF solves daily. From drawing board to target, AMF is constantly bridging the gap between missile concept and performance. • This wealth of experience, gained as a leading contributor to numerous major missile programs, can produce the solution to your particular problem. • For a full description of AMF engineering and production facilities in the missile field, as well as a review of their performance, contact the AMF Defense Products Manager in any of the cities listed below.

- Armament
- Ballistics
- Radar Antennas
- Guided Missile Support Equipment
- Auxiliary Power Supplies
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TELEMETERING COMPONENTS for Severe Environment

IRE SHOW
Booth Nos.
3038 & 3039

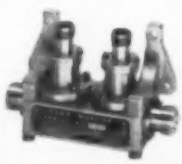
HIGH POWER RF SWITCH, TYPE 1696 will switch a transmitter from one antenna to another at high power levels without mismatching the transmitter for *safe switching under power*. This unit is also applicable for ground use. FREQUENCY RANGE: 215 to 250 Mc/s (other ranges on special order); ATTENUATION: 0.25 db, maximum; POWER RATING: 100 watts R.F. C.W.; VSWR: 1.2 maximum; SWITCHING TIME: .15 sec. average; SIZE: approximately 2½ inch diameter by 4½ inch long; WEIGHT: 2 lbs.; ACTUATING POWER: 6 watts D.C.; CROSS TALK: 27 db down into unused channel; SEQUENCE: Make-before-break.

ANTENNAS, tailored to specific missile requirements.

ENVIRONMENTAL SPECIFICATIONS FOR HIGH POWER RF SWITCH, ANTENNAS, DIPLEXER AND VSWR MONITOR

- **SHOCK: up to 100 G**
- **VIBRATION: up to 20 G at frequency of 2000 cps.**
- **TEMPERATURE:** Type 1696: −40°F to +250°F.
  Antennas and Type 1231: Up to 350°F. (Type 1231 made of Invar may be provided at extra cost for use up to 500°F.)
  Type 1273: Calibration shift of less than 3% between 70°F. and 310°F. Satisfactory operation as low as −40°F.
- **ALTITUDE: Unlimited. All units are hermetically sealed.**

DIPLEXER CAVITY, TYPE 1231
Two Diplexer Cavities and circuitry comprise DIPLEXER which feeds signals from 2 - 100 watt transmitters into a single missile antenna system. Frequency Ranges: 215 to 250 Mc/s, other ranges on request; Frequency Spacing: 3 Mc min.; Size and Wt.; each cavity approx. 3" diam. x 4" long. TRIPLEXER with characteristics similar to Type 1231 can be supplied.



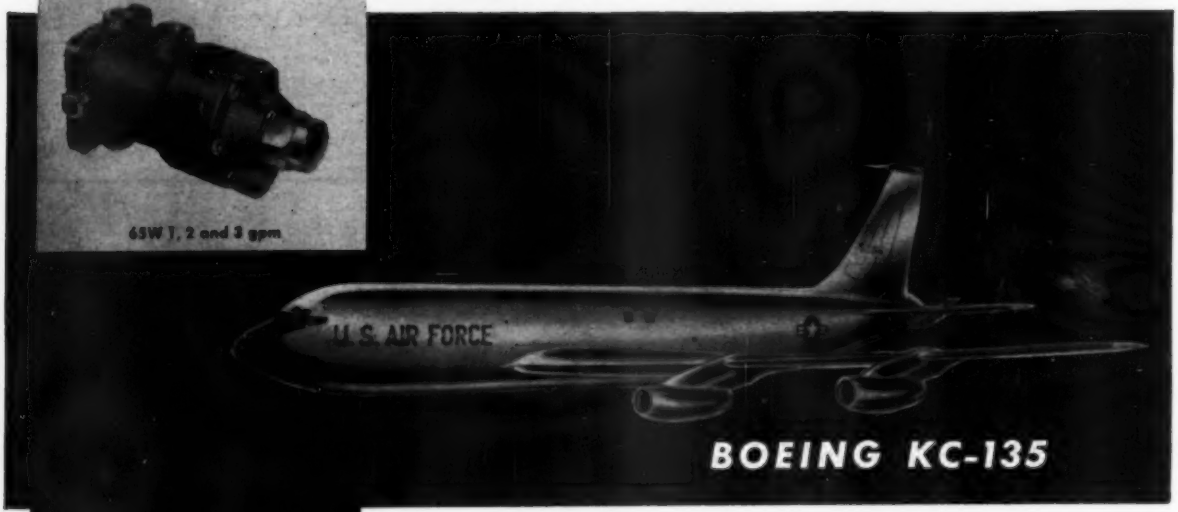
VSWR MONITOR, TYPE 1273
This unit monitors RF Power, VSWR and Side-Tone amplitude and furnishes 2 d-c voltages representing incident and reflected power so that antenna power measurements may be made. Power Handling Capacity: up to 500 watts output to Indicator: one volt (nominal) from 500 ohms. Frequency Range: 100 to 400 Mc/s. Factory calibrated at desired frequency.

HYCON EASTERN, INC.
75 Cambridge Parkway Dept. W Cambridge 42, Massachusetts

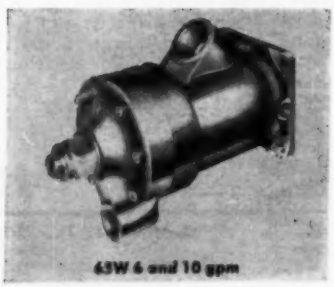
It all adds up!

LIGHT WEIGHT

STRATOPOWER®
AIRCRAFT HYDRAULIC EQUIPMENT



RELIABILITY



High capacity, light-weight 10-gpm pumps from STRATOPOWER's 65W Series have been selected and are now serving on Boeing's KC-135 tanker. The Boeing Airplane Company has also experienced satisfactory service from more than 35,000 other STRATOPOWER pumps on the KB-29, KC-97, B-50, "377", B-47, B-52, "707", and Bomarc. Briefly, what it all adds up to is that STRATOPOWER continues to supply a superior product like the 65W Series to the nation's major aircraft manufacturers for reliable service in all types of aircraft.

Further information about these outstanding pumps will be furnished promptly on request.

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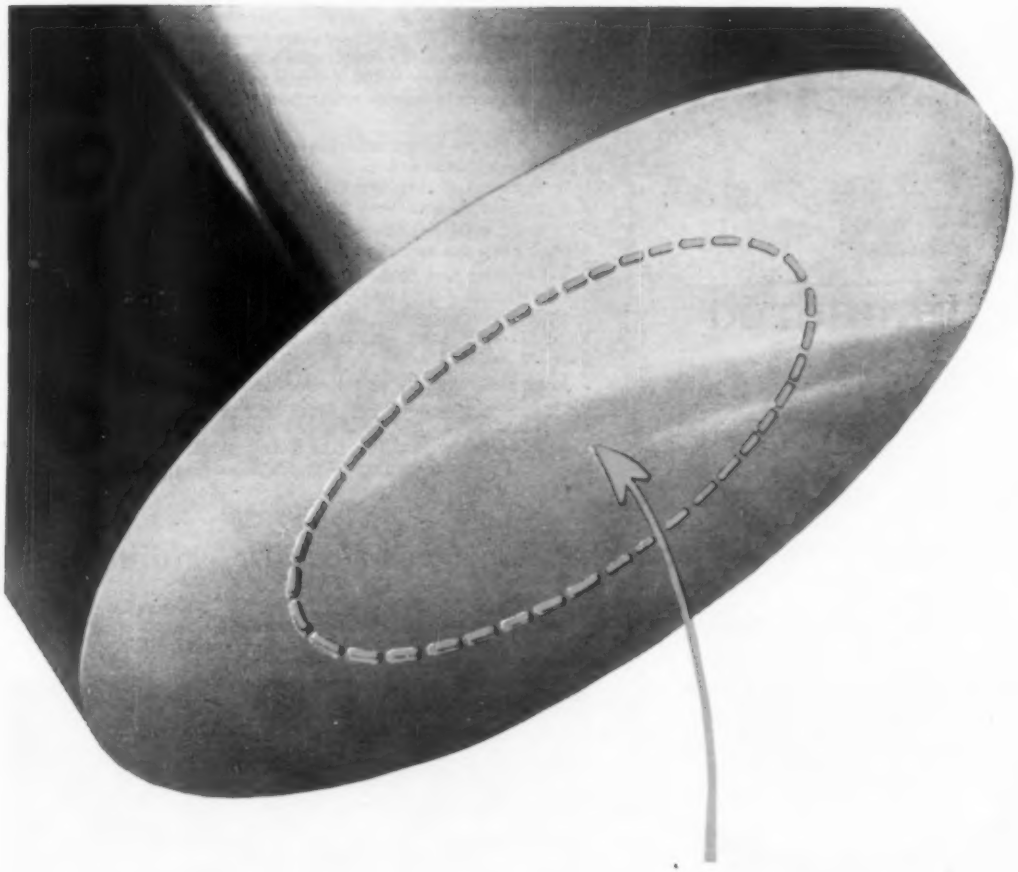

Here's where hollow parts makers can find new savings

IF YOU'RE boring out bar stock to make hollow parts, you can save money, time and steel. Start with Timken® seamless steel tubing because:

1. YOU SAVE THE COST OF DRILLING; the hole's already there. Finish boring becomes your first production step.

2. YOU SAVE MACHINE TIME by eliminating this costly, original boring operation. You free screw machine capacity for other jobs, increase machining stations *without* adding machines.

3. YOU SAVE STEEL BY WASTING LESS and using more of the steel you buy. You get more parts per ton of steel, because there's less metal to hog out.

And you get finished parts of better quality from Timken seamless steel tubing. We forge a solid round over a mandrel, thoroughly working the metal inside and out. This rotary piercing operation gives seamless tubing its fine forged quality and unvarying spiral grain flow. Precise control of temperature and piercing speed helps assure you of uniform quality from tube to tube, heat to heat, order to order.

To save even more steel, have our engineers recommend the one most economical tube size for your hollow parts job. We'll guarantee it to clean up to your finish dimensions. The Timken Roller Bearing Company, Steel and Tube Division, Canton 6, Ohio. Cable address: "TIMROSCO".

TIMKEN *Fine Alloy* **STEEL**

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SPECIALISTS IN FINE ALLOY STEELS, GRAPHITIC TOOL STEELS AND SEAMLESS STEEL TUBING

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One hundred to one

inches are sensitive to over-heat with Fenwal Fire and Over-Heat Detectors

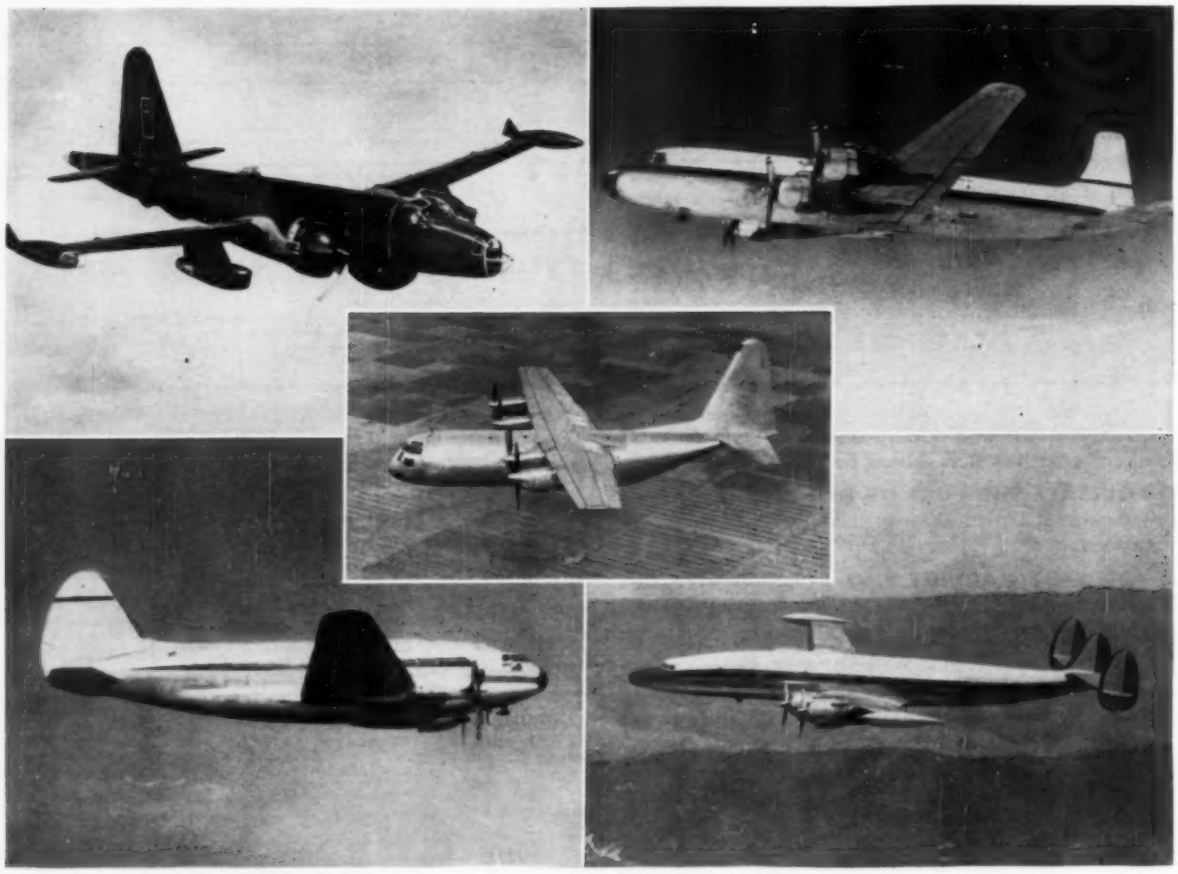
Fenwal Continuous Fire and Over-Heat Detectors are selective — at a given temperature there is a rapid decline in the resistance of the circuit and a signal is given. There's no heat averaging — if 100 inches is over-heated or just one inch the alarm is sure — never false. *That's reliable precise sensing!*

There are no tubes, transistors, relays or moving parts; assembly is quick and easy. Shock and vibration will not bother them and their low impedance prevents false alarms due to moisture. But that's just part of Fenwal's Continuous Fire and Over-Heat story. Each zone is unaffected by any other — *you can have several temperatures in a series!*

Fenwal was first to develop a Continuous Fire and Over-Heat Detector — and its present systems have this 10 years' engineering development experience. There is a Fenwal Fire Detector to fit your requirements. *Maximum reliability is designed into each unit!*

More Fenwal unit Fire Detectors are now flying than any other make. That's the best experience testimonial you can get! Drop us a line at Fenwal Incorporated, Aviation Products Division, 123 Pleasant Street, Ashland, Mass., and we'll send you our catalog — or our Sales Engineer, whichever you want.

These planes are flight-proving Fenwal's Continuous Fire Detector System under actual operating conditions.



Fenwal CONTROLS TEMPERATURE . . . PRECISELY

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Circle Number 7 on Reader-Service Card

AN AID FOR AIR TRAFFIC CONTROL

TIME: 2:00 A.M.

WEATHER: Heavy rain—ceiling 500′—visibility one mile.

SITUATION: Aircraft traffic in and out of International Airport Los Angeles is almost *normal.*

REASON: Positive identification and control of aircraft aided by use of the CHARACTRON Shaped Beam Tube in modern Air Traffic Control Display Systems. Proved in the SAGE system, the CHARACTRON Shaped Beam Tube displays alphanumeric and symbolic information *plus* conventional radar.

RESULT: A constructive step forward in air safety for the fast moving jet-age.

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THE STROMBERG-CARLSON COMPANY, A DIVISION OF GENERAL DYNAMICS CORPORATION

"There is nothing finer than a Stromberg-Carlson"

Pneumatic controls

AiResearch is the largest designer and manufacturer of pneumatic controls for the aircraft and associated industries. During the past 10 years more than 300,000 units have been produced and are in service.

Temperatures of the fluids (including gas and liquids) range from −400°F to +2000°F at pressures to +6000 psig. The units operate at any ambient pressure at ambient temperatures from −300°F to over +1000°F. Line diameters range from ⅛ inch to 15 inches.

This equipment is developed and tested in the finest pneumatic facilities in the world. Your inquiries are invited.

• Outstanding opportunities for qualified engineers

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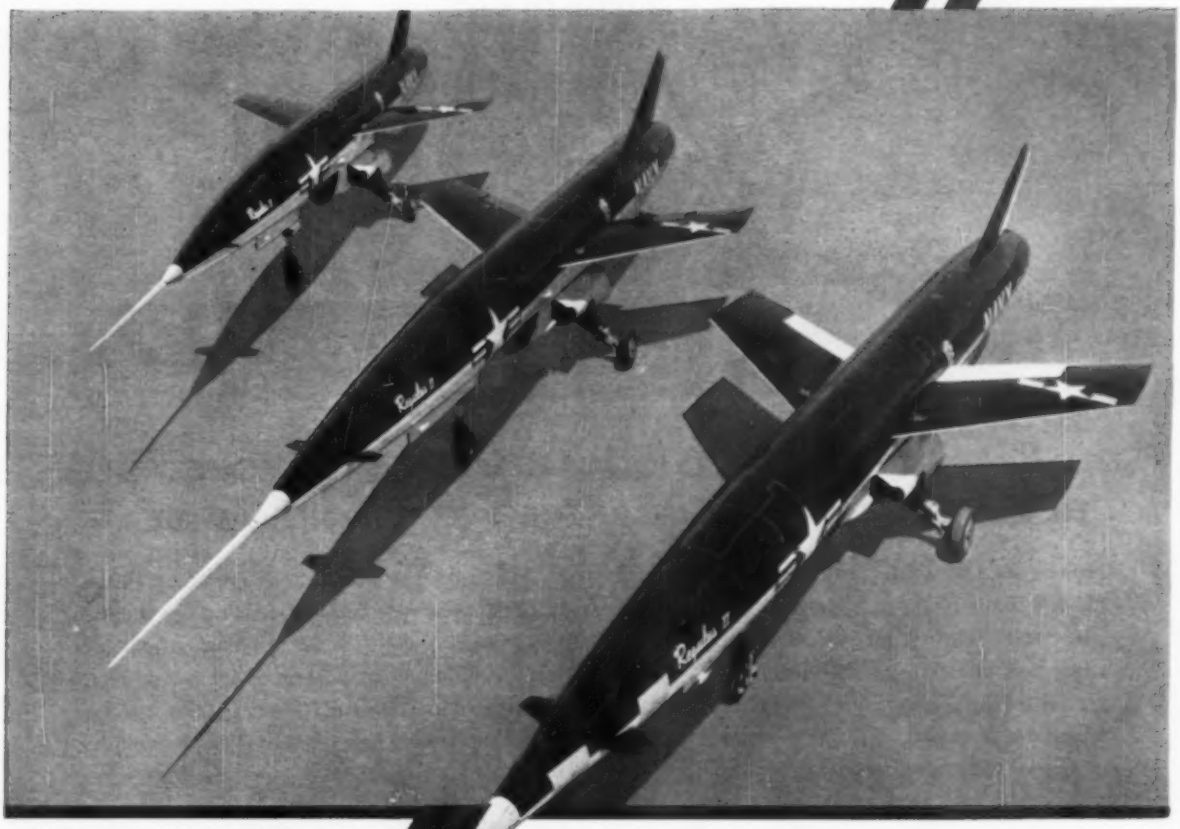
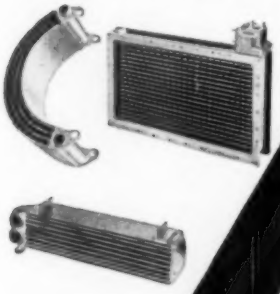
REGULATES HEAT ON REGULUS II



Harrison aircraft oil coolers—engineered and built to General Motors standards of quality.



Harrison-Cooled Regulus II Flies More Than Double The Speed of Sound

The Navy's new Regulus II zooms into space at a blistering speed—to altitudes of more than 60,000 feet! And Harrison heat exchangers are on board, providing the optimum in oil-cooling efficiency—safeguarding engine performance on these spectacular Chance Vought flight test vehicles. Backed by over 47 years' experience, Harrison heat exchangers are rugged, reliable and compact—designed to assure complete dependability under the most severe operating conditions. That's why you'll find Harrison heat transfer equipment on so many of America's foremost weapons of defense—from atomic submarines to supersonic bombers and guided missiles. If you have a cooling problem, look to Harrison for the answer.

TEMPERATURES MADE TO ORDER

HARRISON

GM

HARRISON RADIATOR DIVISION • GENERAL MOTORS CORPORATION • LOCKPORT, N. Y.

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Why

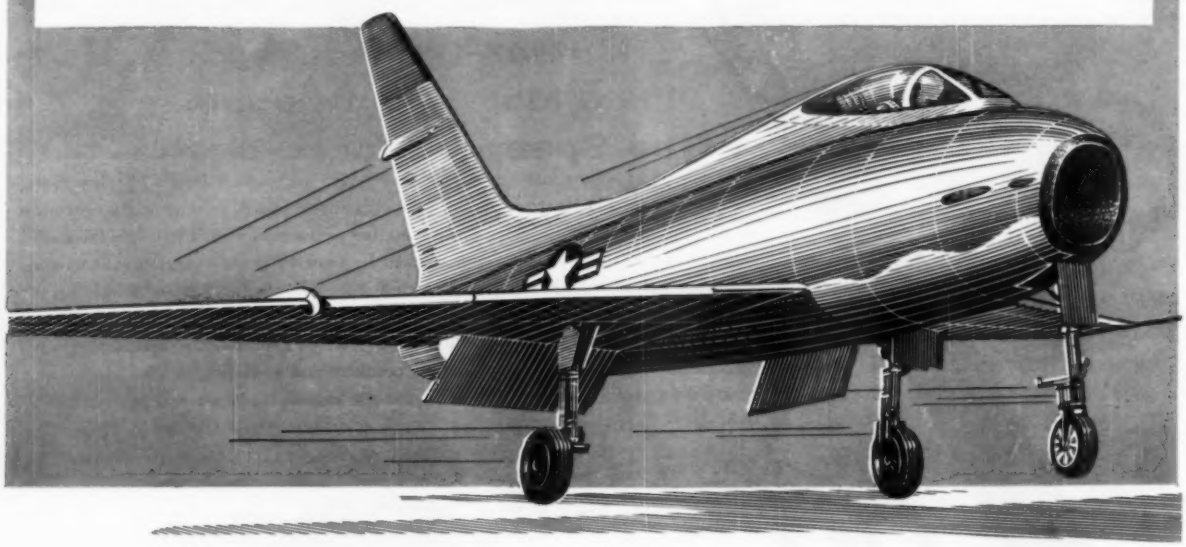
NORTH AMERICAN AVIATION

Chose **menasco**

... *Because* MENASCO COULD MEET OR EXCEED ALL REQUIREMENTS FOR CARRIER JET LANDING GEAR

NORTH AMERICAN FJ series were the first Jet fighters to be qualified aboard aircraft carriers. The latest FJ-4 *Fury* Jet carrier-based fighters are capable of speeds in excess of 600 knots with a service ceiling in excess of 45,000 feet. They have a high rate of climb, and may also serve as carriers of special externally stored weapons.

MENASCO was chosen to design and manufacture the prototype landing gear and has supplied gear for all of the FJ series airplanes. The proper combination and application of lightweight materials and the exclusive *Uniwelding* process have provided landing gear of *great strength, compactness and ruggedness.*



first in development, quality, delivery and service

menasco manufacturing company

BURBANK, CALIFORNIA • FORT WORTH, TEXAS

SPECIALISTS IN AIRCRAFT LANDING GEAR

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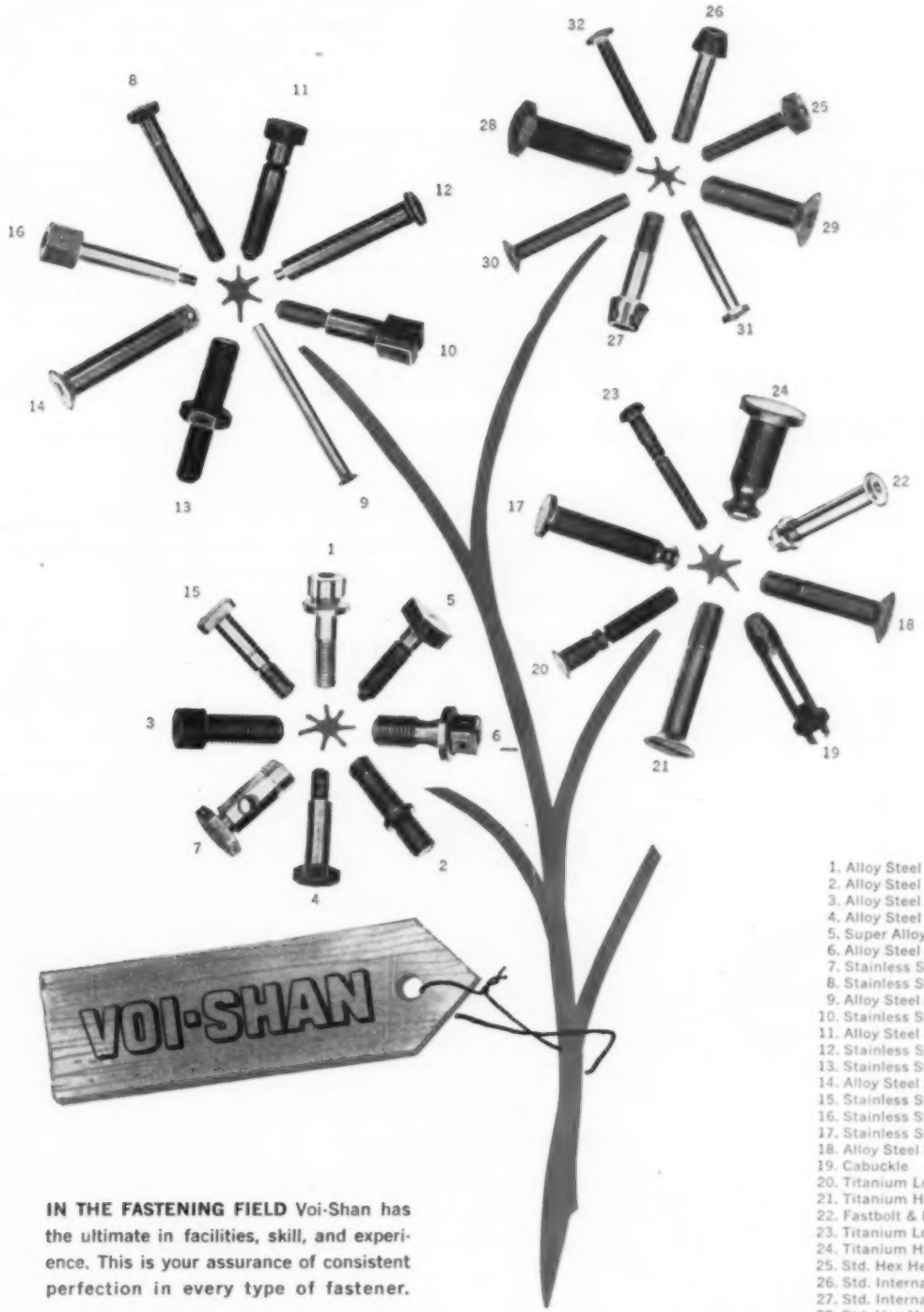
a growing variety of Quality Fasteners



1. Alloy Steel Engine Bolt
2. Alloy Steel Engine Stud
3. Alloy Steel Engine Bolt
4. Alloy Steel Airframe Bolt
5. Super Alloy Engine Bolt
6. Alloy Steel Engine Bolt
7. Stainless Steel Engine Bolt
8. Stainless Steel Engine Bolt
9. Alloy Steel Airframe Bolt
10. Stainless Steel Engine Bolt
11. Alloy Steel Engine Bolt
12. Stainless Steel Engine Pin
13. Stainless Steel Engine Stud
14. Alloy Steel Airframe Bolt
15. Stainless Steel Engine Bolt
16. Stainless Steel Airframe Bolt
17. Stainless Steel Hi-Shear Rivet
18. Alloy Steel Hi-Torque Bolt
19. Cabuckle
20. Titanium Lockbolt
21. Titanium Hi-Torque Bolt
22. Fastbolt & Fastnut
23. Titanium Lockbolt
24. Titanium Hi-Shear Rivet
25. Std. Hex Head Bolt
26. Std. Internal Wrenching Bolt
27. Std. Internal Wrenching Bolt
28. Std. Hex Head Bolt
29. Std. Flush-Head Bolt
30. Std. Flush-Head Bolt
31. Std. Hex Head Bolt
32. Std. Hex Head Bolt

IN THE FASTENING FIELD Voi-Shan has the ultimate in facilities, skill, and experience. This is your assurance of consistent perfection in every type of fastener.

VOI-SHAN MANUFACTURING COMPANY

A division of PHEOLL MANUFACTURING COMPANY
8463 Higuera Street, Culver City, California

Circle Number 11 on Reader-Service Card

WHITE SANDS DIVISION:
Collection of missile data and research and development of equipment for this purpose.

INSTRUMENT & ELECTRONICS DIVISION:
Accomplishing development of new instrumentation techniques and the prototype fabrication of equipment.

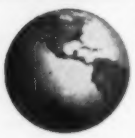
MATTERN X-RAY DIVISION:
The manufacturing area of Land-Air, Inc., which fulfills quantity production requirements.

CHEYENNE DIVISION:
Within this double hangar is a two-fold program of Engineering Design and Aircraft Modification.

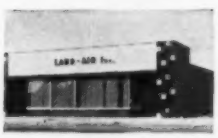
LAND-AIR, Inc.

qualified ability in aviation, electronics and manufacturing

PT. MUGU DIVISION:
Processing photographic and oscillographic data obtained by missile launchings at this Naval Air Missile Test Center.



FIELD OPERATIONS DIVISION:
Supplying aircraft, aircraft engine and electronic technicians on a world-wide basis.



LOS ANGELES DIVISION:
Industry wide data processing concerning organization, buying, inventories, etc. utilizing the latest computer equipment.

STEPPER MOTORS DIVISION:
Producing an incremental rotation, bi-directional motor for missiles and automation.

CHICAGO ENGINEERING DIVISION:
Theoretical study group solving problems in methods and procedures in electronics and mechanics.

Send for the brochure describing our operations in detail.

LAND-AIR, Inc.

Subsidiary of California Eastern Aviation, Inc.

7446 W. Wilson Avenue, Chicago 31, Illinois

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Circle Number 5 on Reader-Service Card →

Z-Z-ZIP

There goes a KB-50 J TANKER!

New efficiency in performance as well as a new sound is being added by HAYES AIRCRAFT CORPORATION to the KB-50 multi-point probe-and-drogue tanker fleet of the Tactical Air Command. With the addition by Hayes of two General Electric J-47 jet engines as supplementary power, these Hayes modified tankers become capable of above the weather in-flight refueling of the fastest and most modern jet fighters, and henceforth will be known as KB-50J tankers.

Low cost of conversion, increased versatility and enlarged scale of performance of these KB-50J jet-augmented tankers is typical of the many different Hayes aircraft modification projects which give the United States more air force per dollar.

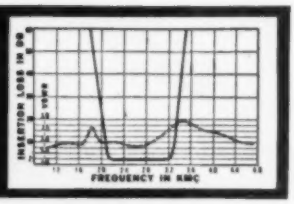
TO ENGINEERS AND SCIENTISTS

The rapid growth and expansion of Hayes creates a need for aeronautical scientists, aircraft design engineers and graduate engineering students. Good positions are open for those who are qualified. Hayes now has over 10,000 employees and is a competitive industrial facility for modification and maintenance of aircraft, including guided missile work. Write Personnel Department, P. O. Box 2287.

Hayes
AIRCRAFT CORPORATION
BIRMINGHAM, ALABAMA

ENGINEERS • DESIGNERS • MANUFACTURERS

Continuously matched filter network. The impedance is approximately 50 ohms, resistive in the stop bands. Provides VSWR of 2.5:1 max. near cut off frequencies. Low and high pass filters can be manufactured with similar characteristics from VHF through X-band frequencies.



MICROPHASE R. F. FILTERS FOR AIRCRAFT, MISSILES

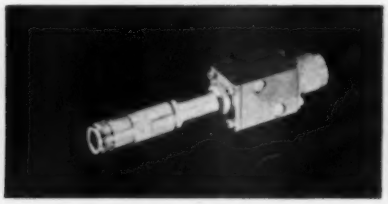
• FLEXIBILITY OF DESIGN

• HIGH PERFORMANCE

• RELIABILITY . . .

Meet your critical filter needs, including severe shock and high temperature requirements. These are typical examples.

BAND PASS – Exceptionally-wide band in X-band range. Provides 15% rise to 60 db at upper and lower cutoff frequencies. Maximum insertion loss in pass band is 2.0 db. Provides DC return path at output for use with crystal detectors that require DC bias.



BAND PASS – Narrow-Band Coaxial in X-band region. Exceptionally sharp rise – less than 5% to 60 db. Insertion loss in pass band is 1.5 db maximum. Band width can be accurately controlled and the pass band placed anywhere in X-band.

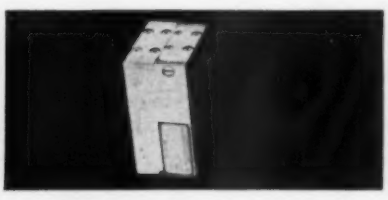
BAND PASS – Special L-band for airborne applications. Size 2 x 4 x ¼ inches. Weight 3½ oz. Also available in VHF through X-band. Sharp rise characteristics on special request.

BAND PASS – S-band three-section tunable cavity type. Approximately 1% band width at the 3 db points, a 1% rise to 60 db from center frequency. Tuning range, 2 to 3 kmc. Insertion loss is approximately 2.5 db.

LOW PASS – Primarily for telemetering isolation purposes, provides greater than 60 db. isolation over 100 mc range with insertion loss less than 1 db. in pass band. Weight only 4½ oz.

LOW PASS – Primarily for telemetering isolation purposes, provides over 60 db isolation in 100 mc range with insertion loss less than 1 db in pass band. Weight only 4½ oz.

TRIPLEXER – Divides UHF, VHF and L-Bands with 40 db isolation. Whole frequency spectrum is usable because power is divided equally at crossovers with negligible loss. Unit has maximum VSWR less than 2.6:1, weighs 14 oz., comes with choice of connectors. Unit is available with 60 db isolation in slightly larger size.



DIPLEXER – Telemetering Diplexer provides minimum of 60 db. isolation between two adjacent channels 5% apart, with insertion loss of less than 1.0 db. Ruggedized and temperature compensated to –70°C with no appreciable drift, for airborne, high-altitude use. Special shapes available.

DIPLEXER – VHF-TACAN Antenna Diplexing filter, improved version of the standard Microphase Type CB-2245 with improved VSWR. Isolation in the TACAN band is 90 db. capable of handling 2 kw peak power.

MICROPHASE CORPORATION

Box 1166 • Greenwich • Connecticut

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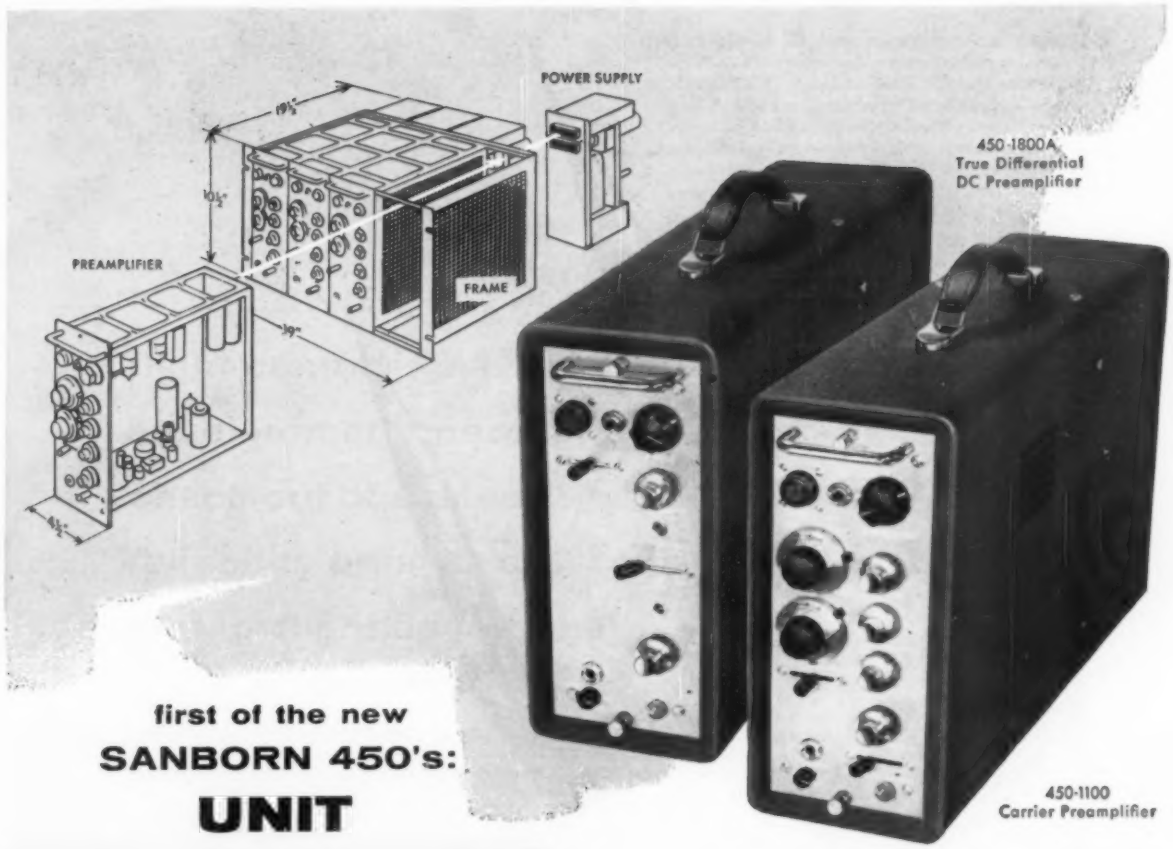


first of the new

SANBORN 450's:

UNIT PREAMPLIFIERS

with Integral Power Supplies

These new Sanborn Unit Preamplifiers—designed to drive optical recording systems, tape recorders, wide band oscilloscopes, panel meters and other devices—offer you an outstanding combination of performance characteristics, operating versatility and ease, flexibility through interchangeable design, and compactness in either single unit or four-unit rack module packaging. The 1100 Carrier and 1800A True Differential DC types are versatile enough to cover the vast majority of input signal requirements, with practically any type of transducer. (For use with high speed optical galvanometers at frequencies above 500 cps, requiring larger current swings, a transistor output amplifier is built into the 450-1800A and available as optional equipment on other 450's.) Later "450" Unit Preamplifiers will include Servo (demodulator) Monitor, DC Coupling, Logarithmic, Low Level and Dual-Channel DC types. As shown, any "450" can be installed or quickly interchanged in any bay of the four-Preamp module, or in a portable case.

Supplementing the basic specifications, the 450-1100 is a carrier amplifier-demodulator with zero suppression, which provides excitation for and accepts the outputs of various resistance bridge, variable reluctance, differential transformer and other types of transducers. The 450-1800A is a low-noise, low drift, wide band-width, high gain true differential DC amplifier, with front panel controls for smooth gain, position, and internal 2 mv calibration signal. For further data or application information on these new self-contained Unit Preamplifiers, contact your Sanborn Industrial Engineering Representative or write the Industrial Division of Sanborn Company.

SANBORN COMPANY

175 Wyman St., Waltham 54, Mass.

SPECIFICATION SUMMARY

MODEL 450-1800A TRUE DIFFERENTIAL DC PREAMPLIFIER

Input — Impedance: 200K differentially between terminals (balanced) or 100K each input lead to gnd. (single-ended)
Common mode rejection: at DC, 100 db; to 60 cps, 94 db; 400 cps, 80 db.
Equiv. input drift: ±2 uv for 24 hours
Equiv. input noise: 5 uv peak to peak (0–10 cps), 20 uv (0–1000 cps), 50 uv (0–30 kc)

Output — Low Power Circuit:
Output appears between two cathodes as true push pull signal.
Common mode level of cathodes ±.2 volts with respect to ground.
Output capability: ±3 volts into 5000 ohms
±10 volts open circuit
Zero position control not active for this output
Freq. response: 3 db down at 30 kc
Linearity: 0.1%
High Power Circuit:
Output appears between two emitters as true push pull signal.
Common mode level of emitters ±2.5 volts with respect to ground.
Preferred load: 50 ohms
Output: ±2.5 volts, ±50 ma
Freq. response: 3 db down at 15 kc
Linearity: 0.5%
Zero position control is operative for high power output ckt.

Gain — Fixed steps 1000, 500, 200, 100, 50, 20
Gain Accuracy 0.5% for D.C.
Smooth gain control covers range between fixed steps

Power Req. — 115 volts, 60 cps, approx. 50 watts

MODEL 450-1100 CARRIER PREAMPLIFIER

Carrier Freq. — 2400 cps (std.); 600, 1200, 4800 cps optional

Carrier Exc. — approx. 4.5–5 volts, depending on transducer imped.

Transducer Imped. — 100 ohms min. - 1000 ohms max.

Input Imped. — approx. 2500 ohms, incl. zero sup. ckt.

Sensitivity — 100 uv rms from transducer (output imped. 1000 ohms or less) gives 1 volt at output under max. output loading

Output — preferred circuit: between one active cathode and one reference cathode
alternate circuit: between active cathode and ground

Output Voltage Capabilities — (a) ±3 volts into 2.2K min. load
(b) ±6 volts into 5K load
(c) ±7.5 volts open ckt.

Output Linearity — better than 0.2% for (a) above

Output Impedance — approx. 1000 ohms, preferred ckt., 500 ohms alternate output ckt.

Freq. Response — 3db at 20% of carrier freq.

Zero Suppression — can suppress 0 to 100% of transducer load (either sense via switch)

Power Req. — 115 volts, 50–400 cps, approx. 30 watts

Circle Number 14 on Reader-Service Card

THE LOCKHEED F-104 STARFIGHTER

—world's fastest, highest-flying operational airplane

Lockheed's ultrasonic "missile with a man in it" can outrace the sun from New York to San Francisco. When necessary, it can zoom into the upper stratosphere to perform its vital day-and-night missions.

Less than 55 feet long, with knife-sharp 7¼-foot wings, the F-104 *Starfighter* packs awesome firepower. Each wing tip can carry a Sidewinder missile—which is guided to its target by an infrared tracking device (which "feels" the presence of other aircraft by the heat they radiate).

No other fighter plane in USAF history has been so thoroughly performance-proved before entering service. For over three years Air Force and Lockheed pilots, engineers and scientists have subjected the F-104 *Starfighter*, its electronic components and armament to the most punishing tests they could devise. This new pre-service procedure assures maximum utilization of the F-104—starting with its very first mission for the Air Defense Command.

LOCKHEED
means leadership

Lockheed Aircraft Corporation
California Division, Burbank, California

NOW IN SERVICE!

with the 83rd Fighter-Interceptor Squadron, Air Defense Command, USAF, Hamilton AFB, California

Circle Number 16 on Reader-Service Card

New GENISCO flight control accelerometer permits check out of system reliability prior to, or during, flight operations

This newest Genisco instrument is a modified version of the unusually rugged, military certified Model DDL Accelerometer. The Model DDL was developed specifically to withstand severe vibration and stress in high-speed aircraft, guided missile and fire control system applications. It is now in use on many of the nation's fastest operational jet fighter aircraft.

In the new Model DDT two miniaturized solenoids have been added to the basic design of the Model DDL. When actuated, these solenoids displace the mass through its full range permitting rapid, functional tests of system reliability prior to, or during, flight operation.

Only brief specifications of the Model DDT are given below. Copies of Technical Data Sheets giving complete specifications will be sent upon request.

Because most parts of the new Model DDT are interchangeable with the Model DDL now in high-quantity production, price and delivery are particularly good.

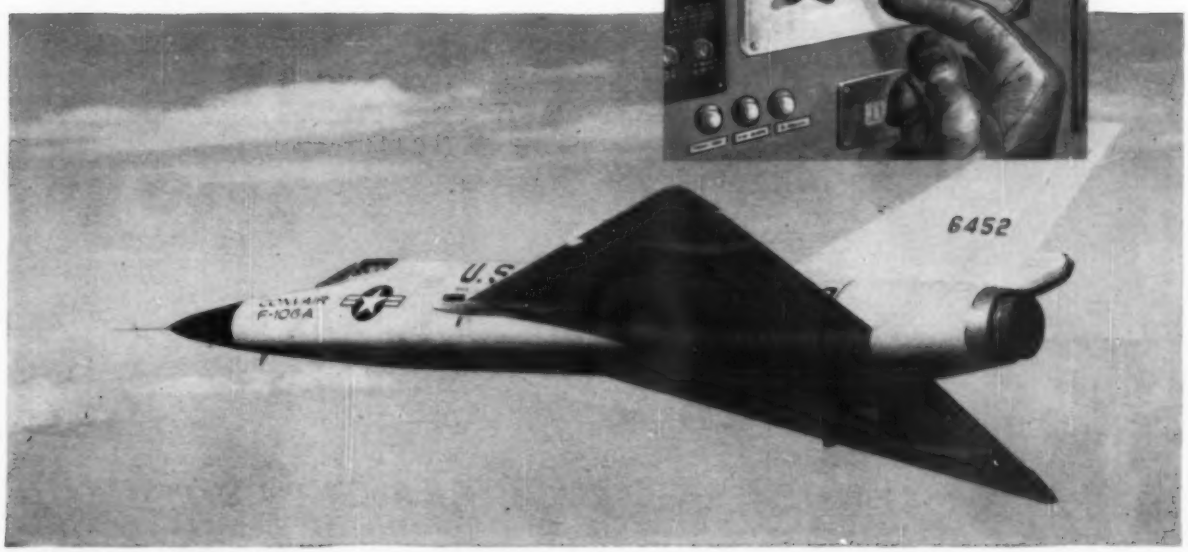


Photo courtesy Convair, San Diego

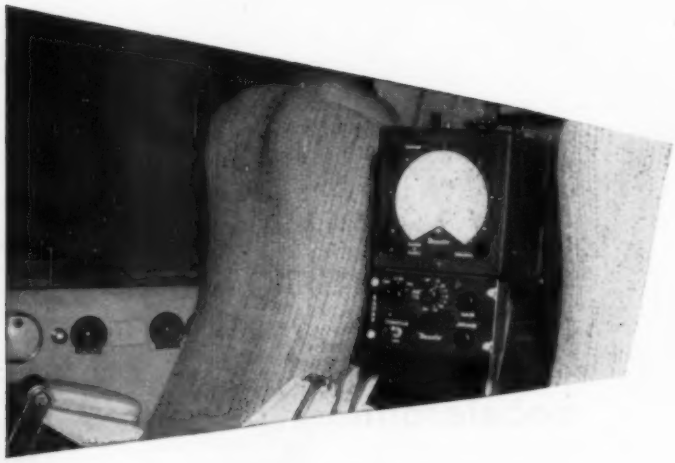
Genisco
INCORPORATED

2233 FEDERAL AVENUE • LOS ANGELES 64 • CALIFORNIA

BRIEF SPECIFICATIONS

Range: ±0.1 G to ±7.5 G's.
Natural Frequency: 5 cps to 27 cps.
Linearity: ±1% of full scale for balanced range instruments.
Damping: Nominally 0.7 of critical at +75°F.
Temperature: Operates to specifications between −65°F. to +275°F.
Vibration: 10 G's at 10 to 1500 cps on any axis.
Shock: 40 G's of 7 ms duration on non-sensitive axes; 100% overload of 7 ms duration on sensitive axis.
Pressure: Operates to specifications at any altitude.
Size: 3½" x 2½" x 4", approx.
Weight: 3.2 lbs.

Inquiries to determine possible variations welcomed.



For greater safety—

BENDIX WEATHER RADAR

on more executive aircraft

than any other make

If you want to know more about the many safety advantages of Bendix* Weather Radar guided flight, write for the brochure "Airborne Radar System". Address: Aviation Electronic Products Department. *REG. U. S. PAT. OFF.

Bendix Radio Division

BALTIMORE 4, MARYLAND

Bendix AVIATION CORPORATION

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Circle Number 19 on Reader-Service Card→

Beware of the Snark!

The nation's first intercontinental missile . . . the Air Force's Northrop Snark SM-62. Equipped with a nuclear warhead, the Snark is a so-called air-breathing missile which travels in the earth's atmosphere. Its compact design presents a smaller target for radar, interceptors, or anti-aircraft missiles.

Extremely mobile, the Snark can be air lifted to any site within a few hours.

The pilotless bomber is powered by a Pratt-Whitney Aircraft J-57 turbo-jet engine equipped with a Holley compressor bleed governor. It flies in near-sonic speeds above the weather over the longest range yet possible by a missile in the free world today.

Like all Holley engine controls, the compressor bleed governor is dependable, easy to service, compact and lightweight — four vital qualities for aviation equipment.

HOLLEY
Carburetor Co.

LEADER IN THE DESIGN, DEVELOPMENT, AND MANUFACTURE OF AVIATION FUEL METERING DEVICES.

11955 E. NINE MILE ROAD, VAN DYKE, MICHIGAN

A-23

CHECK HOBART MGC

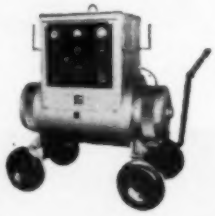
. . . for precision and accuracy in 400 cycle

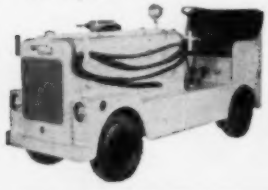
400 cycle 60 kva motor generator set

For the coming new jet transports, as well as for the military jet advancements, there is an even greater need for closely regulated, dependable 400 cycle generators. You need not look any further than the complete Hobart line—many models to choose from, all designed to do the specific job you have. You have a big investment in your aircraft and controls. Protect that investment with the best available equipment for ground tests and checks. It's better to buy the best than wish you had.

ELECTRIC MOTOR DRIVEN

Induction motor driven 400 cycle generators with capacities of 3.75 to 37.5 KVA. Synchronous motor driven generators with capacities of 7.5 to 12.5 KVA. Furnished complete with all controls and instruments. Ideal for production or test line, or missile launchers.





SELF-PROPELLED

For busy airports and test areas, this self-propelled design saves space and time. 400 cycle AC generators of this type are available in similar capacities as trailer type.

GAS ENGINE DRIVEN

Commercial and military models are in production. 400 cycle AC generators with capacities from 12.5 to 125 KVA, gas engine driven, or 37.5 to 125 KVA with Diesel engine drive.

. . . also CHECK these versatile DC units–

A dependable source of regulated 28 volt DC power is still required for many commercial military aircraft and missile applications. Hobart generators, designed for your specific job, give you many time and cost saving advantages.

NOW . . . a high speed, over-the-road, ground power unit. Available in two models, 1000 or 1500 amperes, 28.5 volts, DC, this mobile power plant will deliver auxiliary power anywhere on the airport. 400 cycle AC also available truck mounted.

Gas Engine Driven: Capacities of 200 to 1500 ampere for jet or reciprocating engine starting and aircraft testing. For flight line use away from electric power. Complete with all controls, DC cable and portable mounting.

WRITE, WIRE OR PHONE—NOW—FOR COMPLETE DETAILS.

MOTOR GENERATOR CORPORATION

Box AV-38, Troy, Ohio, U.S.A. *HOBART BROTHERS AFFILIATE*

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Circle Number 21 on Reader-Service Card→

Out of advanced research, development and production at Hoffman

GYROS

FOR INERTIAL NAVIGATION AND GUIDANCE SYSTEMS

Designed and Developed by Humphrey, Inc., San Diego, California

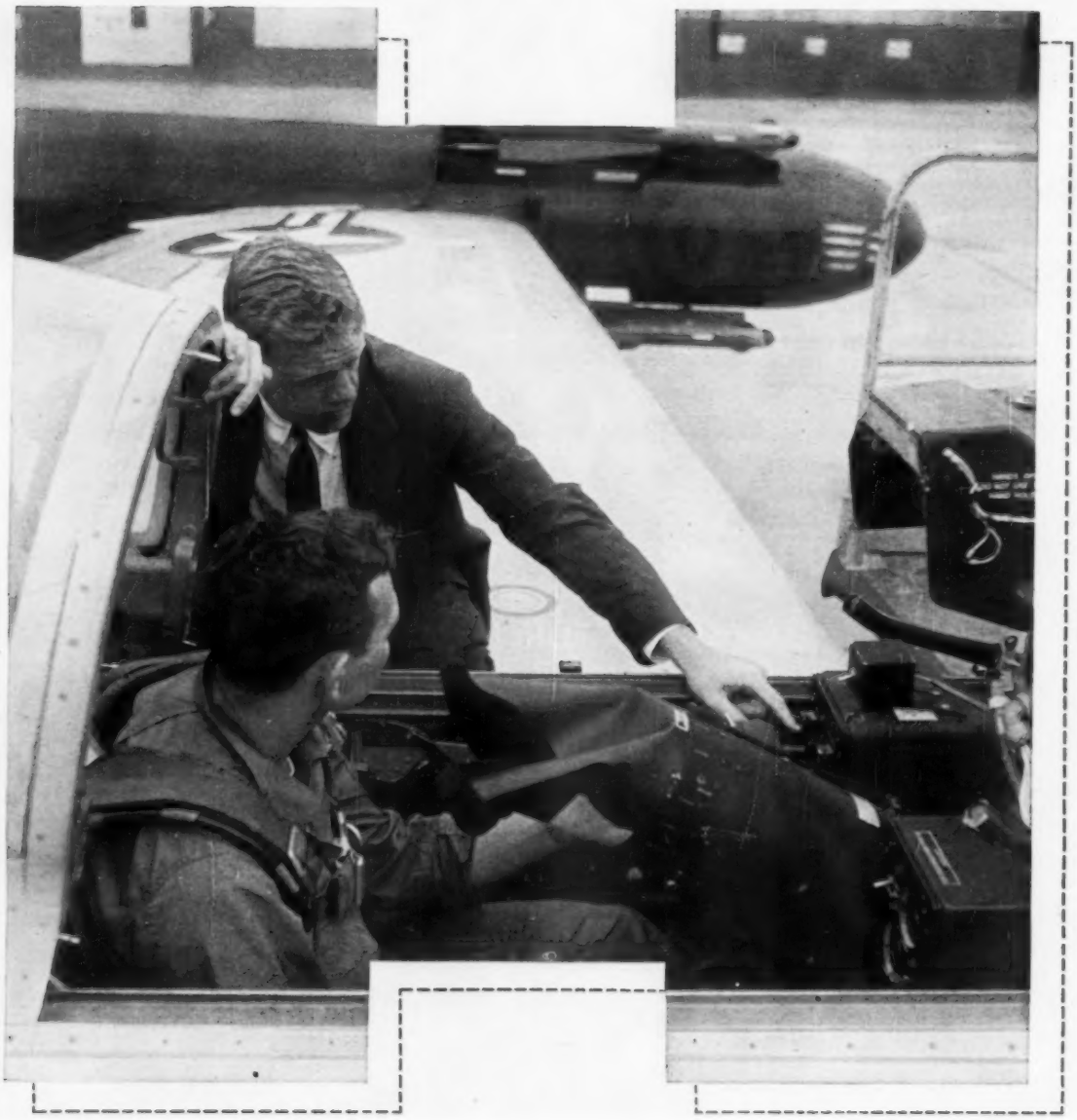
Electro-Mechanical Equipment—such as the Air Force's ASN-6 Automatic Dead Reckoning Navigation Computer now in production at Hoffman—include gyroscopes, inertial navigation systems and components, servomechanisms, fire control systems, and guided missile controls. These are examples of the special Hoffman skills and electro-mechanical capabilities which can help solve your design problems.

Hoffman Electronics CORPORATION

HOFFMAN LABORATORIES DIVISION / 3740 South Grand Avenue, Los Angeles 7, California
Research, Development & Production · Weapons Systems · Radar
Communications · Electronic Counter Measures · Navigation · Missile Support Equipment
Semiconductor Applications · Electro-Mechanical Equipment

Significant new developments at Hoffman have created important positions for scientists and engineers of high calibre. Please address inquiries to Vice-President, Engineering.

SKY WARRIOR WITH HIS



FEET ON THE GROUND

The advent of complex jet warfare has created a new, highly respected type of engineer—the Hughes Field Engineer. Responsible for the modification and maintenance of complex Electronics Armament Systems and guided missiles, he keeps in the forefront of the newest electronics developments.

The Hughes Field Engineer, working with complete integrated systems, learns how each component contributes toward the working, fighting total. He is given the opportunity to work with electronics systems right where they prove themselves—in actual use.

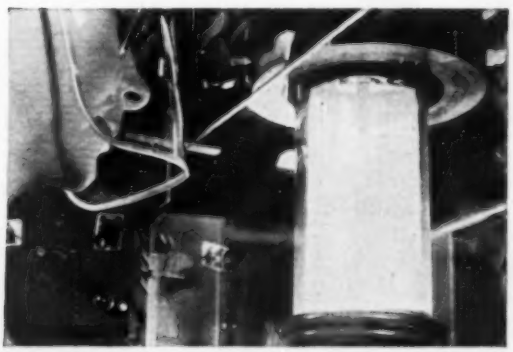
The Hughes Field Engineer is the final link in a strong chain. The Research and Development Laboratories form the first link by initiating the basic designs for the new system. The Hughes manufacturing facilities produce the system, "building in reliability" with the most advanced techniques in testing. As the final link, the Field Engineer makes the system produce everything that was built into it.

The complete cycle of Research, Development, Manufacture, and Service is also evident in other Hughes activities. The commercial products activity performs all these phases in the areas of electron tubes, semiconductor devices, and industrial systems and controls. The Ground Systems Division performs all phases on protective radar systems. This diversity and wide scope of activity has made Hughes an ideal firm for present and prospective employees interested in career advancement.

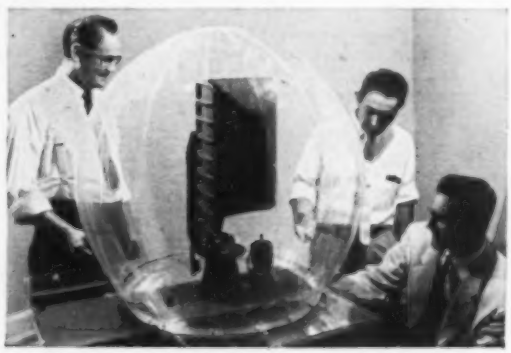
Some of the highly rewarding positions now open include:

Computers	Solid State Physics
Microwaves	Semiconductor Sales
Reliability	Semiconductor Applications
Circuit Design	Systems Analysis

Write, briefly outlining your experience, to Mr. Phil N. Scheid, Hughes General Offices, Buillding 17N, Culver City, California.



Molten Ladle of silicon is watched during first step in the precise manufacture of Hughes semiconductors. Constant innovations in Research, Development and Manufacture have positioned Hughes Products as a commercial electronics leader.



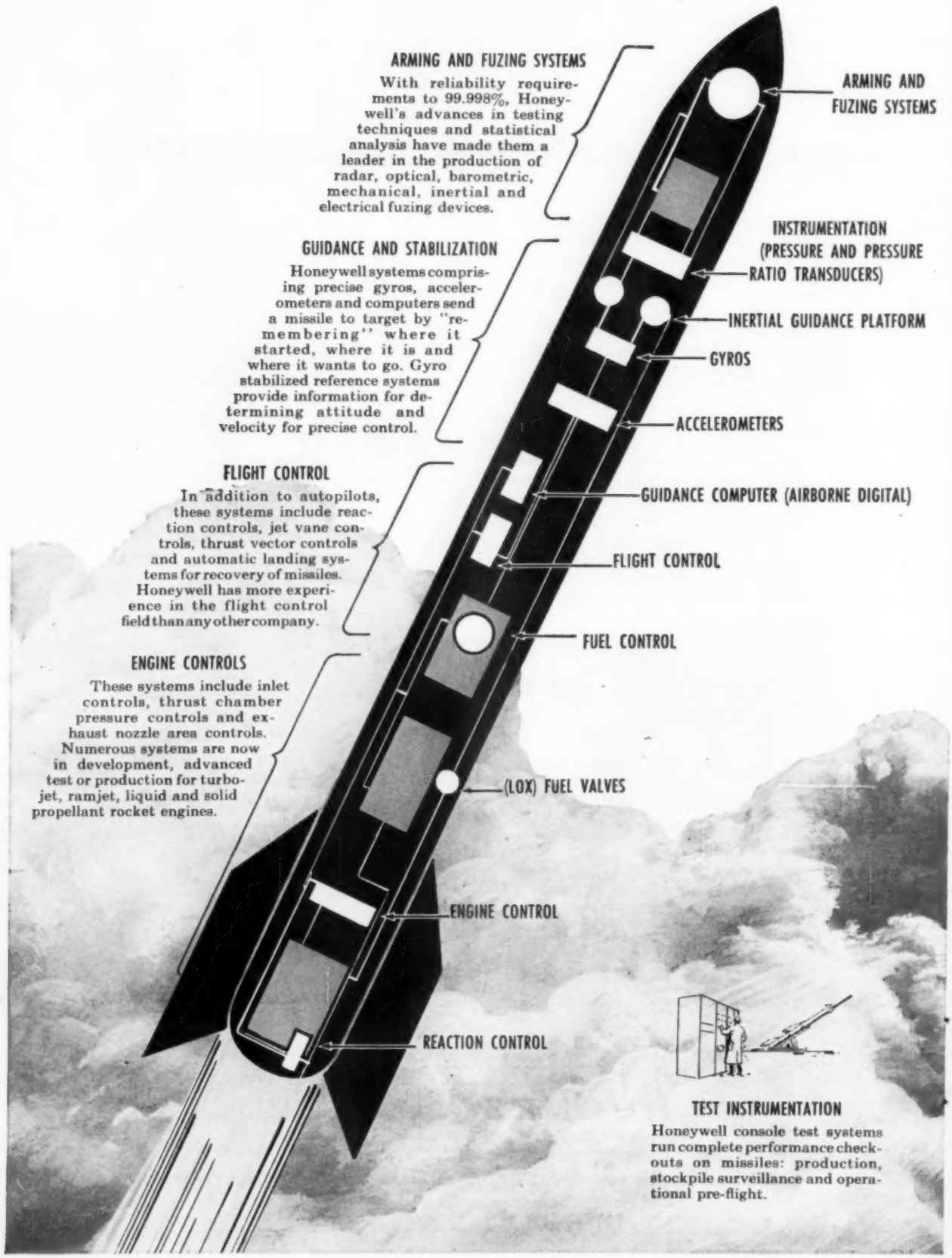
Electronic Scanning Radar systems, a radically new concept in radar beam positioning, is currently being developed and manufactured by the Hughes Ground Systems Division.

Creating a new world with ELECTRONICS

HUGHES

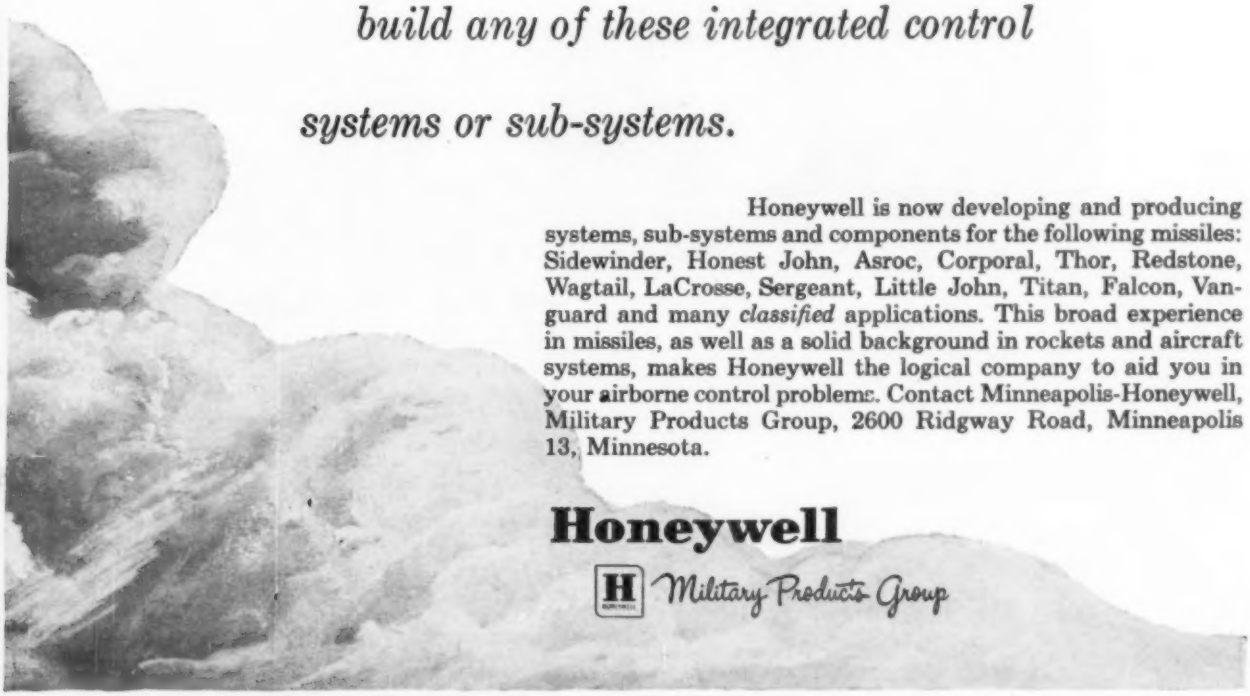
HUGHES AIRCRAFT COMPANY
Culver City, El Segundo,
Fullerton, Los Angeles, California
Tucson, Arizona

Visit our booths at the I.R.E. SHOW *(Booths 2801-03-05) or visit the Hughes suite at the convention hotel.*


ARMING AND FUZING SYSTEMS
With reliability requirements to 99.998%, Honeywell's advances in testing techniques and statistical analysis have made them a leader in the production of radar, optical, barometric, mechanical, inertial and electrical fuzing devices.
GUIDANCE AND STABILIZATION
Honeywell systems comprising precise gyros, accelerometers and computers send a missile to target by "remembering" where it started, where it is and where it wants to go. Gyro stabilized reference systems provide information for determining attitude and velocity for precise control.
FLIGHT CONTROL
In addition to autopilots, these systems include reaction controls, jet vane controls, thrust vector controls and automatic landing systems for recovery of missiles. Honeywell has more experience in the flight control field than any other company.
ENGINE CONTROLS
These systems include inlet controls, thrust chamber pressure controls and exhaust nozzle area controls. Numerous systems are now in development, advanced test or production for turbojet, ramjet, liquid and solid propellant rocket engines.
ARMING AND FUZING SYSTEMS
INSTRUMENTATION (PRESSURE AND PRESSURE RATIO TRANSDUCERS)
INERTIAL GUIDANCE PLATFORM
GYROS
ACCELEROMETERS
GUIDANCE COMPUTER (AIRBORNE DIGITAL)
FLIGHT CONTROL
FUEL CONTROL
(LOX) FUEL VALVES
ENGINE CONTROL
REACTION CONTROL
TEST INSTRUMENTATION
Honeywell console test systems run complete performance checkouts on missiles: production, stockpile surveillance and operational pre-flight.

How many brains make a missile?

Control systems are the brains that guide, control and explode missiles. Honeywell can build any of these integrated control systems or sub-systems.



Honeywell is now developing and producing systems, sub-systems and components for the following missiles: Sidewinder, Honest John, Asroc, Corporal, Thor, Redstone, Wagtail, LaCrosse, Sergeant, Little John, Titan, Falcon, Vanguard and many *classified* applications. This broad experience in missiles, as well as a solid background in rockets and aircraft systems, makes Honeywell the logical company to aid you in your airborne control problems. Contact Minneapolis-Honeywell, Military Products Group, 2600 Ridgway Road, Minneapolis 13, Minnesota.

Honeywell

H Military Products Group

FJ-4B BUDDY TANKER
Will Aid Fleet Units

Longer fighter sweeps and combat air patrols are assured with Flight Refueling's Probe and Drogue "Buddy" aerial refueling equipment, installed on North American FJ-4B Fury fighters now in service with the Fleet.

• Designed and manufactured by Flight Refueling, Inc., these efficient refueling units are typical of the results obtained through the long-range research and development programs initiated by FRI.

• Flight Refueling's devices for Fast Fuel Transfer and fuel system applications are designed to handle all liquids and gases, conventional and special types, for mobile weapons and nuclear installations.

• Manufactured to highest government specifications by personnel experienced in precision fabrication and quality control, Flight Refueling's components are operationally proved and dependable.

FLUID PROBLEM?

Flight Refueling, Inc., engineering specialists can help solve that fluid system problem of yours, too. Our experience includes design and manufacture of systems and components for handling fluids at high flow rates and high pressures, under the most difficult operating conditions.

Flight Refueling, Inc.

FRIENDSHIP INTERNATIONAL AIRPORT Baltimore 3, Maryland

West Coast Representative: *William E. Davis, P. O. Box 642, Inglewood, Calif.*
Dayton Representative: *Fred J. Kendell, P. O. Box 622, Far Hills Sta., Dayton, O.*

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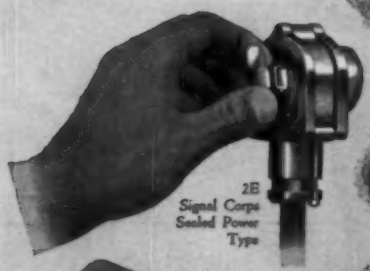
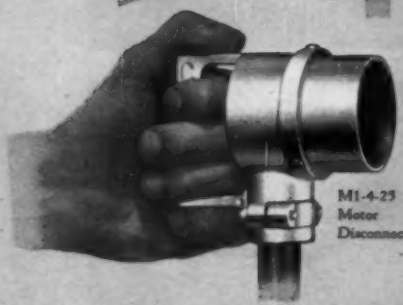
POWER CONNECTORS



2E
Signal Corps
Sealed Power
Type



M1-4-25
Motor
Disconnect

GB Engine Starting Type

#11751-1
Aircraft Battery
Disconnect

CA25019 Aircraft
Power Disconnect

We're pushing power! . . . High-quality Cannon power connectors for all types of aircraft and stationary engines. All are exceptionally rugged units, designed and built for safe, positive connection and long-lasting service. High-current power types from 250 to 600 amp.; medium range 30 amp.

2E Type . . . 10-20 amp., 2800v ac rms flashover, 4, 9, 14, 19 contacts. For ground Signal Corps equipment.

M1 Type . . . 30 amp., 250v ac, 4 contacts.

GB Type . . . 600 amp. and 40 amp., 3 contacts typical. Other GB types for external power, stationary engines, etc.

11751-1 . . . for aircraft batteries, two 600 amp. contacts.

CA25019 . . . field maintenance type, 400 amp. and 40 amp., is similar to CA2551 except that it is made to fit square mating shell section on receptacle.

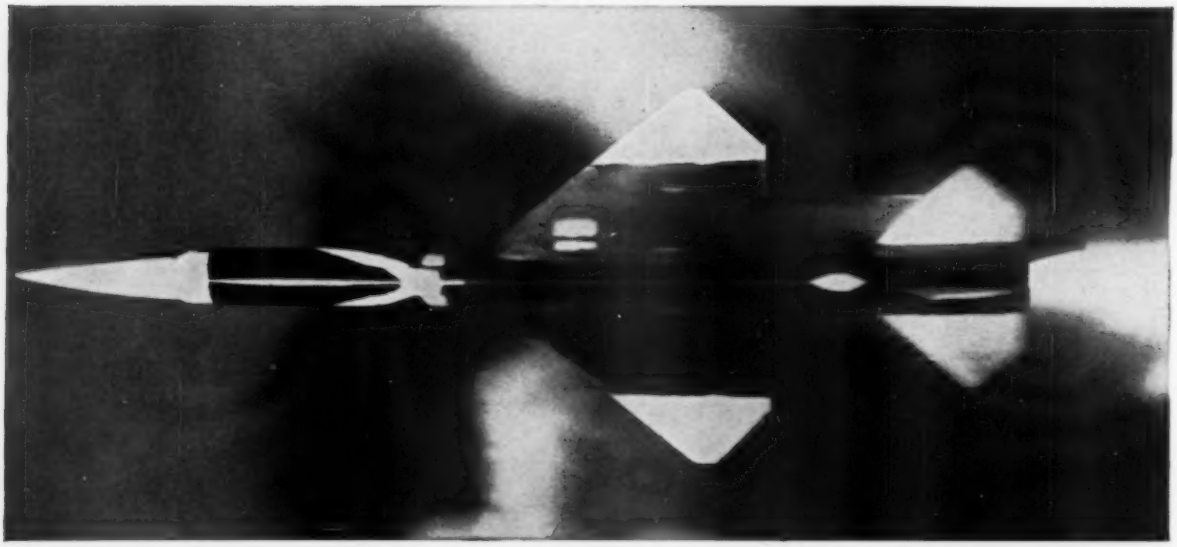
Complete data in "GB" Bulletin, "M" Bulletin. "2E" Bulletin, "BU" Bulletin.

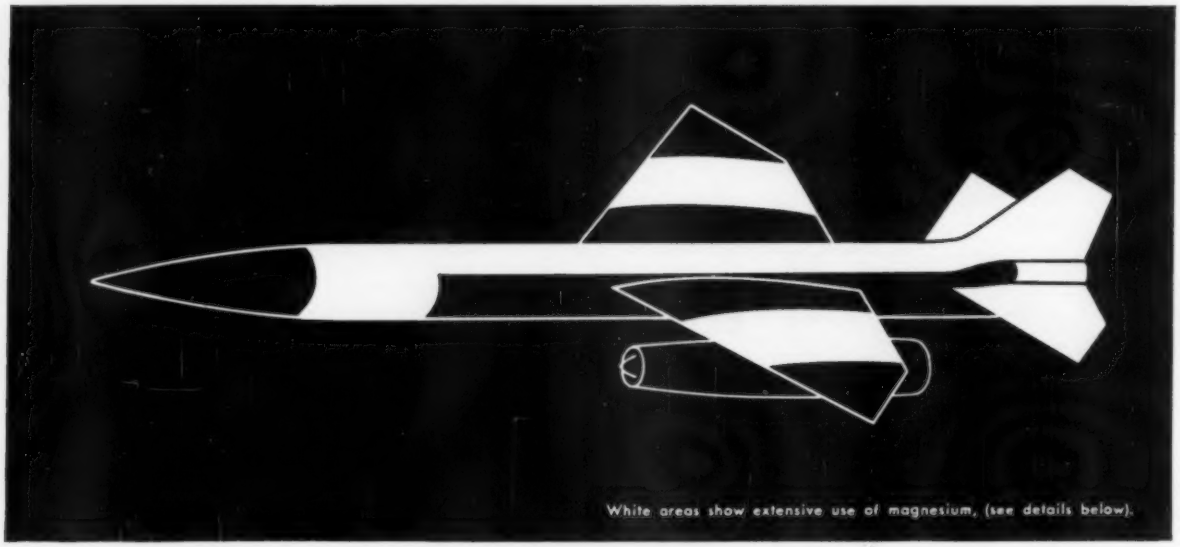
CANNON PLUGS

Please Refer to Dept. 110

CANNON ELECTRIC COMPANY
3208 Humboldt St., Los Angeles 31, Calif.

World's largest exclusive manufacturer of electric connectors for industry





White areas show extensive use of magnesium, (see details below).

HOW ELEVATED-TEMPERATURE MAGNESIUM ALLOYS HELP BOMARC KEEP FIGHTING WEIGHT

Approximately 230 lbs. of magnesium is used in the airframe of the Bomarc, powerful surface-to-air missile. And for good reason: In each case, the specific application called for light weight and retention of strength, rigidity and other properties at elevated temperatures. The logical choice was sheet, extrusions or castings of elevated-temperature magnesium alloys.

EXAMPLES:

BODY. The body skin and doors of both nose and aft sections utilize 103 lbs. of HK31A sheet and castings. Resultant weight savings were 23 lbs., including a net reduction of 6 lbs. by using a magnesium casting for a door frame structure.

WING, FIN AND TAIL. 111 lbs. of HK31A sheet were used in the wing, elevators and elevator stubs, fin and rudder. All leading and trailing edges of control surfaces for wings and fin are HM31XA extrusions. Here another 8 lbs. were saved by using an elevated-temperature magnesium alloy.

These are but a few instances of how precious weight was saved in the Bomarc. For more information about the use of magnesium alloys in aircraft, rockets and missiles, contact the nearest Dow sales office or write directly to us. THE DOW CHEMICAL COMPANY, Midland, Michigan, Department MA 1407K.

YOU CAN DEPEND ON DOW

Circle Number 26 on Reader-Service Card

High-flying "Hustler" equipped with Auto-Lite 350 Wire

Convair's B-58 "Hustler," designed for supersonic, high-altitude operation, uses Auto-Lite 350 High-Temperature Wire in many critical applications. Auto-Lite 350 Wire was developed to meet the extreme temperature and other physical demands of modern aircraft.

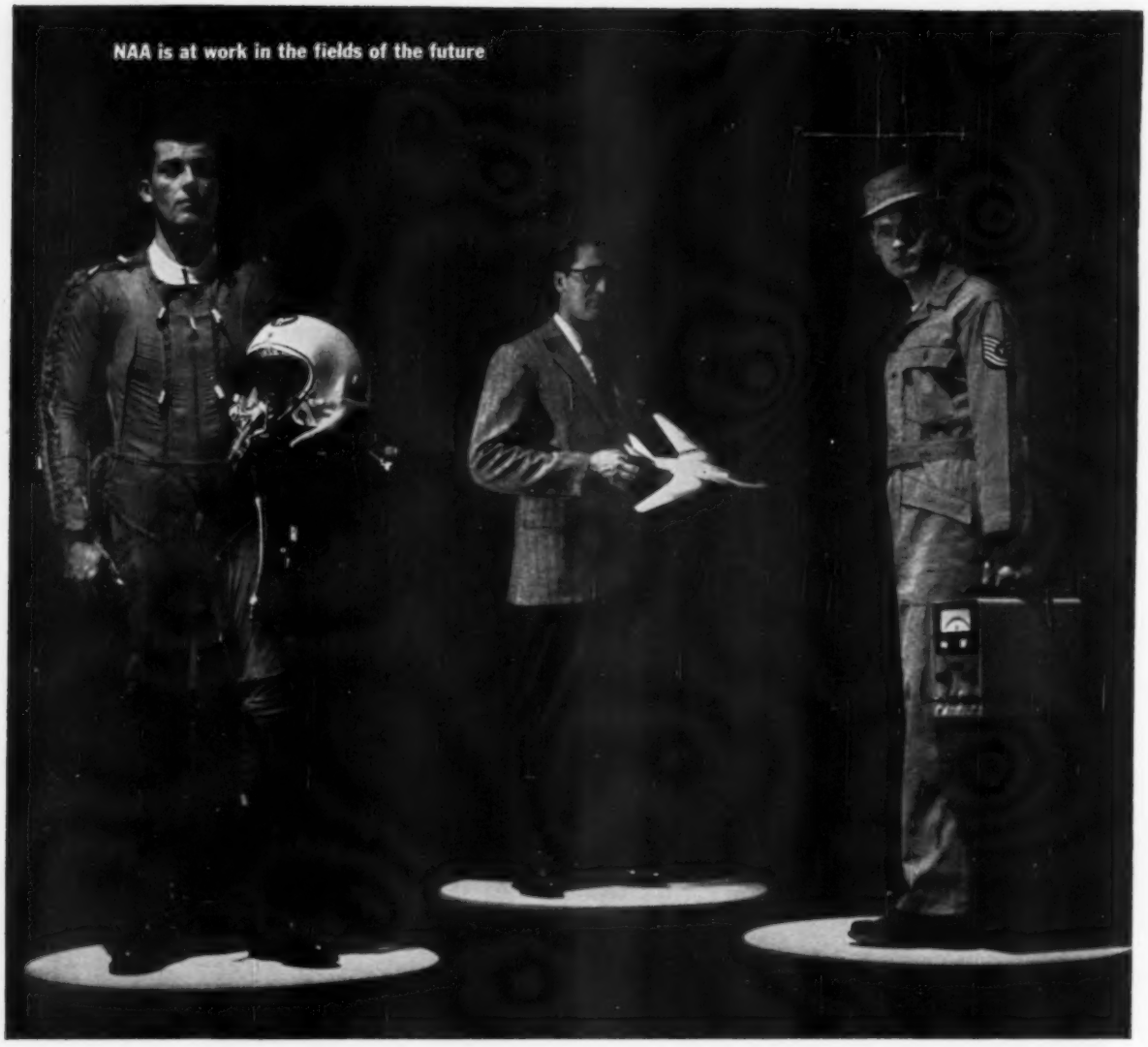
Other airframe manufacturers, like Convair, find the extra temperature range performance of Auto-Lite 350 Wire ideally suited to jet aircraft demands. Many manufacturers find that in addition to its high resistance to abrasion, flame, solvents, fuels, and lubricants, Auto-Lite 350 Wire reduces production costs, too, compared to other high-temperature wires.

- Flexible at temperatures below —80° F.
- Smokeless
- Resistant to modern aircraft hydraulic fluids, lubricants, and fuels for both reciprocating and jet-type engines
- No discoloration at maximum operating cable temperatures
- Flame-resistant
- Easy printing of circuits with conventional marking machines
- Meets Spec. MIL-W-8777, U.S.A.F.
- Free stripping
- Manufactured in sizes 22 thru 2/0

For complete information on Auto-Lite Aircraft Wire, including specifications and samples, write to . . .
The Electric Auto-Lite Company, Wire and Cable Division, Port Huron, Michigan or Hazleton, Pennsylvania

AUTO-LITE® 350 GENERAL PURPOSE HIGH-TEMPERATURE AIRCRAFT WIRE

Circle Number 27 on Reader-Service Card



On these three men depends America's conquest of Outer Space

Very soon now an American is going to ride a rocket ship to the edge of space—and back.

The success of this first flight—and of the others that will follow—depends on the teamwork of the men who build the rocket ship, the men who become its ground-support technicians, and the men who form its air crew. For only the closest coordination of America's industrial, technical, and military skills can achieve the conquest of space.

The X-15: Space Ship No. 1

The craft that is being readied for this first flight into space is the X-15, a rocket-powered research plane for the Air Force, Navy, and National Advisory Committee for Aeronautics. So advanced in design it might be called a manned missile, it's the forerunner of the craft that will cruise through Outer Space.

The assignment to design, build, and test the X-15 is being carried out by North American.

Reliability Room. Automatic control systems for America's manned and unmanned weapon systems must do their critical tasks with unfailing reliability. Even a tiny fleck of dust might impair their vital accuracy. That is why Autonetics assembles its control systems with surgical precision in this dust-free room.

Destination: Outer Space. A man will soon look out on space from cockpit of the X-15, rocket-powered research plane now being readied for its flight test.

Planes, brains and rockets

North American's key role in this great drive to put man into space is the result of its capabilities in the new technologies that make such a flight possible.

In supersonic aircraft, North American has had more experience than all other companies combined. In automatic controls—the electronic "brains" that will guide and navigate the X-15—its Autonetics Division has pioneered some of the most significant advances in recent years. Its Missile Development Division—pioneer of America's missile technology—is at work on an advanced air-to-ground (or space-to-earth) missile for the Air Force. And, in rocket propulsion, NAA's Rocketdyne Division is already delivering the great engines for America's major missiles—Atlas and Thor for the Air Force... Jupiter and Redstone for the Army.

After the breakthrough

These divisions of North American are making many important scientific breakthroughs in this race to space. But even more important is the ability North American has demonstrated, time and again, to turn today's experimental flights into tomorrow's standard weapon system—swiftly, surely, and at lowest possible cost. For every breakthrough is only a new beginning; it's the *followthrough* that gets the results.

Ground support for space

One of the Armed Services' most difficult problems in the Space Age will be the increasing workload on their expensively trained technical manpower. That is why North American is designing a new kind of simplified maintenance into all airplanes, components, and automatic control systems.

This program will pay off in three ways: more efficient use of special skills; more complete utilization of weapons; more defense for the taxpayer's dollar.

In the arts of peace, NAA's Atomics International Division has developed two nuclear reactors that show great promise as practical sources of electric power.

Today in North American Aviation and its divisions, you'll find as potent a combination of scientists, engineers, and production men as any in American industry. Because these men are constantly forging ahead into vital new technologies, much of their work holds great promise for science and industry.

Rocket Power. NAA's Rocketdyne Division builds rocket engines with thrust to drive Air Force's Atlas missile—or to launch an earth-circling satellite.

NORTH AMERICAN AVIATION, INC.

SERVING THE NATION'S INTEREST FIRST—THROUGH THESE DIVISIONS

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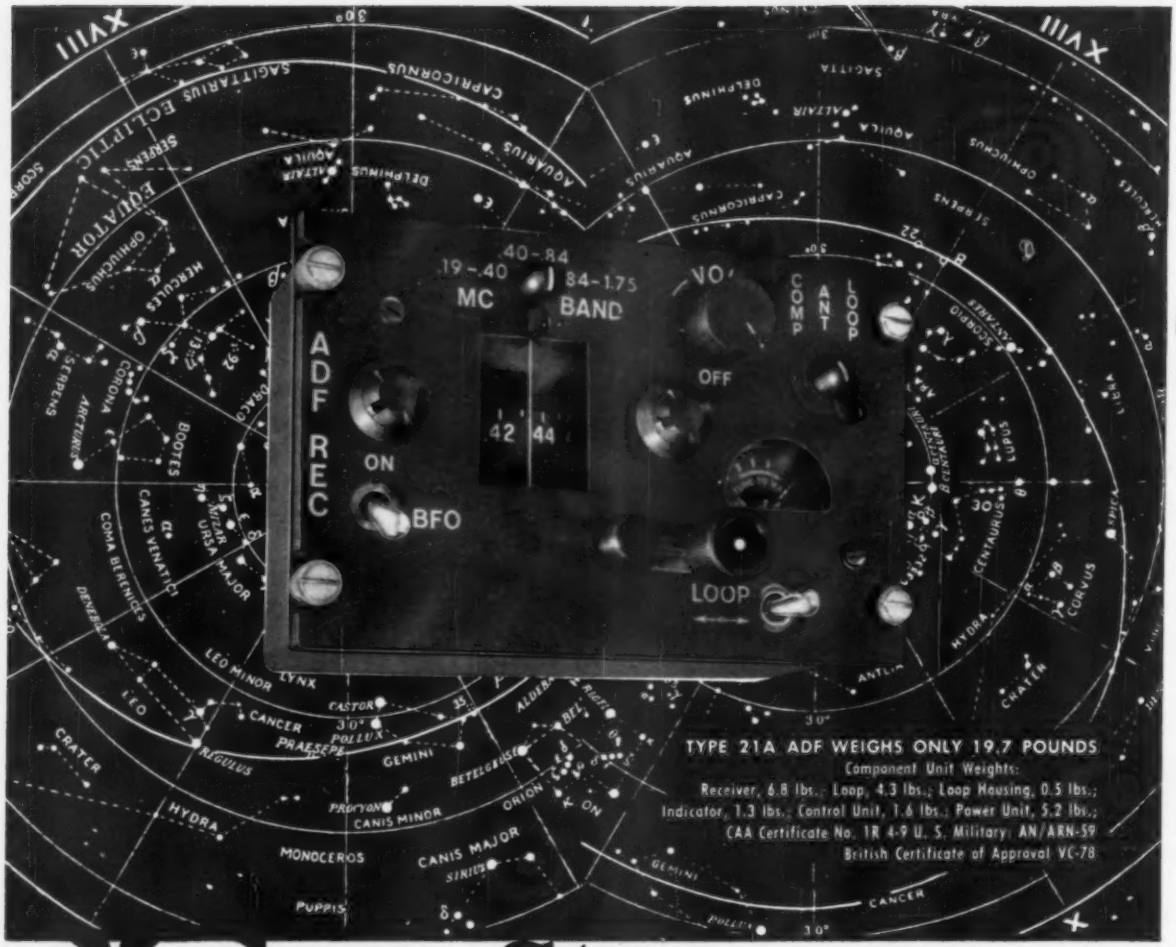

Modern Star

For World-Wide Aircraft Navigation

ARC's TYPE 21A AUTOMATIC DIRECTION FINDER

Because it can be tuned to some 60,000 transmitters, spread all over the world, the ADF is a widely used navigation aid. Important news about the ADF, however, is that ARC has engineered this basic instrument down to less than 20 pounds in weight, with a comparable saving of space.

Now pilots enjoy the advantages of dual installations of this compact miniaturized equipment in tolerable weight and space requirements.

The ARC Type 21A ADF is built to today's more critical speed and environmental demands. It has hermetic sealing of vital components, such as the entire loop assembly. It covers all frequencies from 190 kc to 1750 kc . . . operates on only 2.8 amps at 27.5 volts dc input or equal power at 13.5 volts. A significant feature is the extremely low loop drag — only two inches outside the aircraft skin.

Ask your dealer for detailed literature.

Dependable Airborne Electronic Equipment Since 1928

Aircraft Radio Corporation BOONTON, N. J.

30 YEARS OF ACHIEVEMENT IN AIRBORNE ELECTRONICS — ARC — 1928 1958

OMNI/LOC RECEIVERS • MINIATURIZED AUTOMATIC DIRECTION FINDERS • COURSE DIRECTORS • LF RECEIVERS AND LOOP DIRECTION FINDERS
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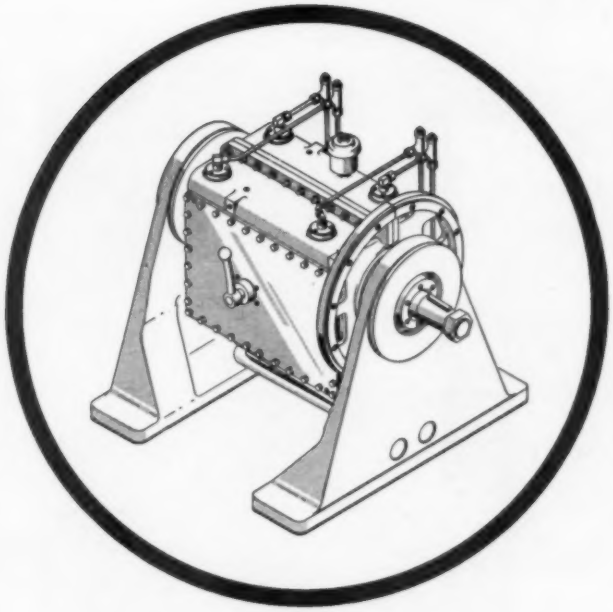


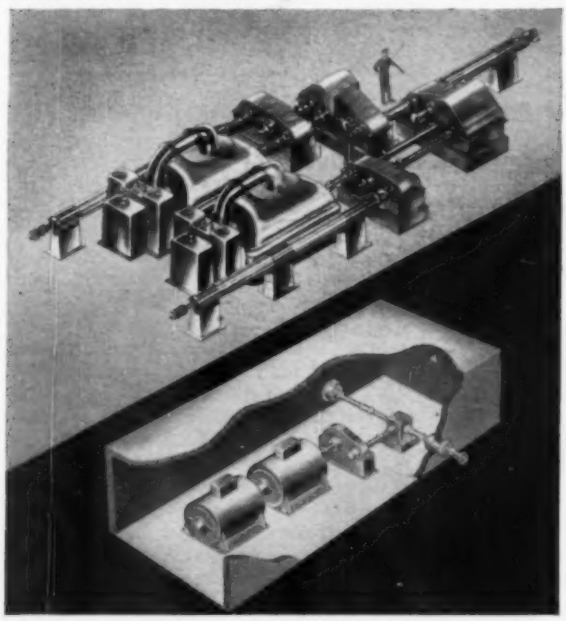
Here's a trunnion-mounted, multi-speed unit used with a dynamometer test facility for guided missile pumps. This unit has a top output speed of 60,000 RPM with a pitch line velocity in excess of 30,000 FPM or more than 340 miles per hour. Unit measures approximately 25 inches in length.

WESTERN GEAR

TEST STANDS and DRIVES...designed to

50,000 HP or 100,000 RPM

This giant test stand facility was designed for use by a leading Eastern aircraft manufacturer. The 2 steam turbines deliver 22,500 HP each. Top output speed is 9,000 RPM and the pitch line velocity is 30,000 FPM.



This test cell presented an "impossible" problem . . . how to transmit 3,000 HP at 7,000 RPM through a right angle gear box? The wall-mounted gear boxes are provided with quick change gear sets which can be shifted from 7,000 to 11,000 and 17,000 RPM. Inspection after unprecedented hours of service show the gearing to be in excellent condition.

Circle Number 30 on Reader-Service Card

Western Gear is designing and building drives and test stands for leading missile-components manufacturers and development laboratories ranging up to 50,000 H.P. or 100,000 RPM. Successful tests have carried designs to 200,000 RPM. Pictured on this page are three recent applications. Note the coupon below.

"The difference is reliability" • Since 1888

WESTERN GEAR Corporation
ENGINEERS AND MANUFACTURERS

PLANTS AT LYNWOOD, PASADENA, BELMONT, SAN FRANCISCO, (CALIF.)
SEATTLE AND HOUSTON... REPRESENTATIVES IN PRINCIPAL CITIES

Use this coupon or call your Western Gear Man. In all principal cities.

5703

Glenn Malmo • WESTERN GEAR CORPORATION
P.O. Box 182 • Lynwood, California
Please send engineering data on your test stand and drives projects.

NAME_____

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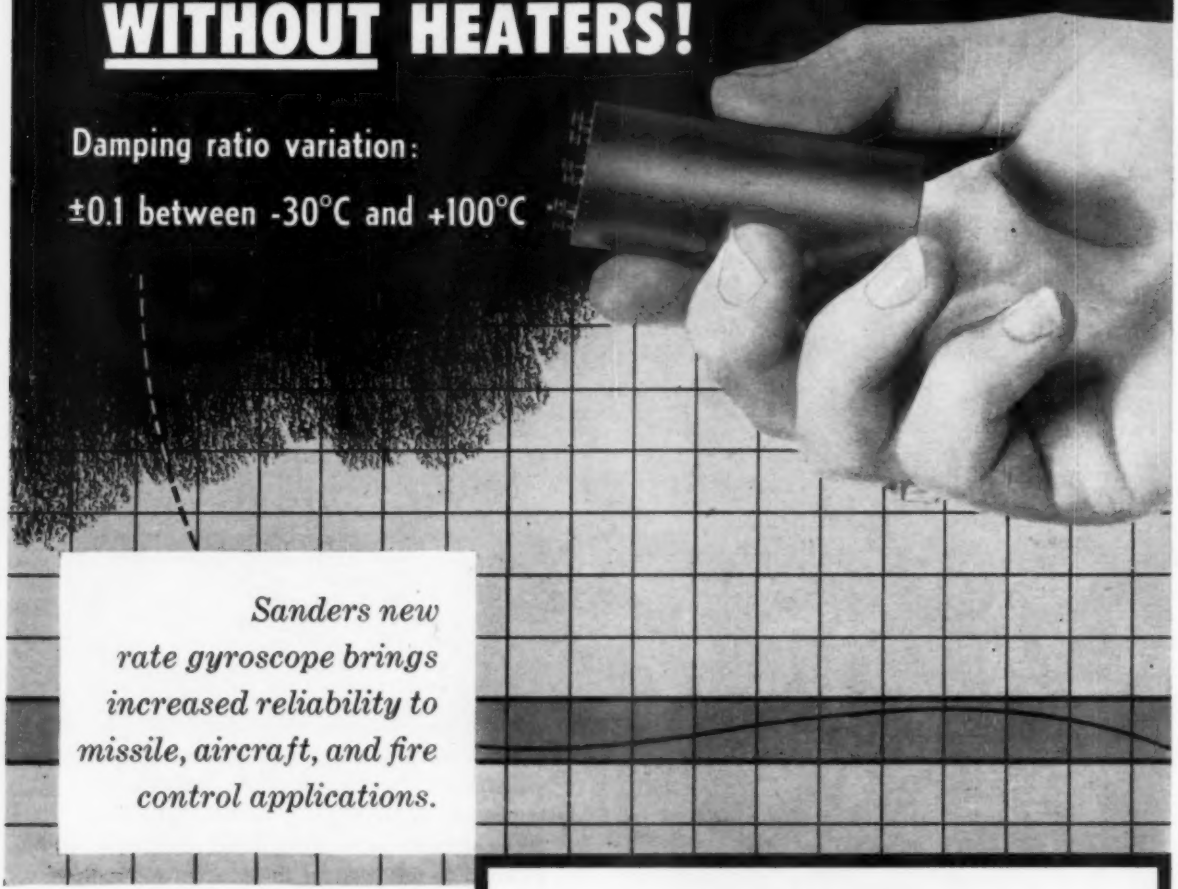
CONSTANT GYRO DAMPING...

WITHOUT HEATERS!

Damping ratio variation:

±0.1 between -30°C and +100°C



Sanders new rate gyroscope brings increased reliability to missile, aircraft, and fire control applications.

A new, simplified fluid temperature compensating mechanism, using *no linkages*, gives this precision subminiature instrument a constant damping characteristic despite changes in damping fluid viscosity. In addition, this new Sanders gyro, Type RGB, retains many of the outstanding design features of Sanders Type RGA gyro . . . in mass production since 1952.

Sanders' diversified experience in electromechanics and electronics can help solve your instrumentation problems. Extensive engineering and manufacturing facilities are available for designing and producing many types of gyros and accelerometers, as well as complete control and guidance systems.

SPECIFICATIONS

Input Rates (full scale)	±40 to ±1000 deg/sec
Nominal Damping Ratio	0.5 ±0.1 from −30°C to +100°C
Resolution	0.01% full scale
Linearity	±0.1% to half scale
Sensitivity	5.6 mv/deg/sec to 140 mv/deg/sec
Zero Set (External Adjustment)	0.05% full scale
Hysteresis	±0.15% full scale
Pickoff Output	5.6 vrms with standard excitation
Size	15/16" D x 2 1/2" L
Weight	4 1/2 oz
Vibration	Up to 70g from zero to 2000 cps
Shock	Up to 100g
Acceleration	Up to 100g
Operating Temp. Range	−55°C to +100°C

SANDERS ASSOCIATES, INC.

NASHUA, NEW HAMPSHIRE • *Dayton, Ohio* • *Inglewood, California* • *Washington, D. C.*

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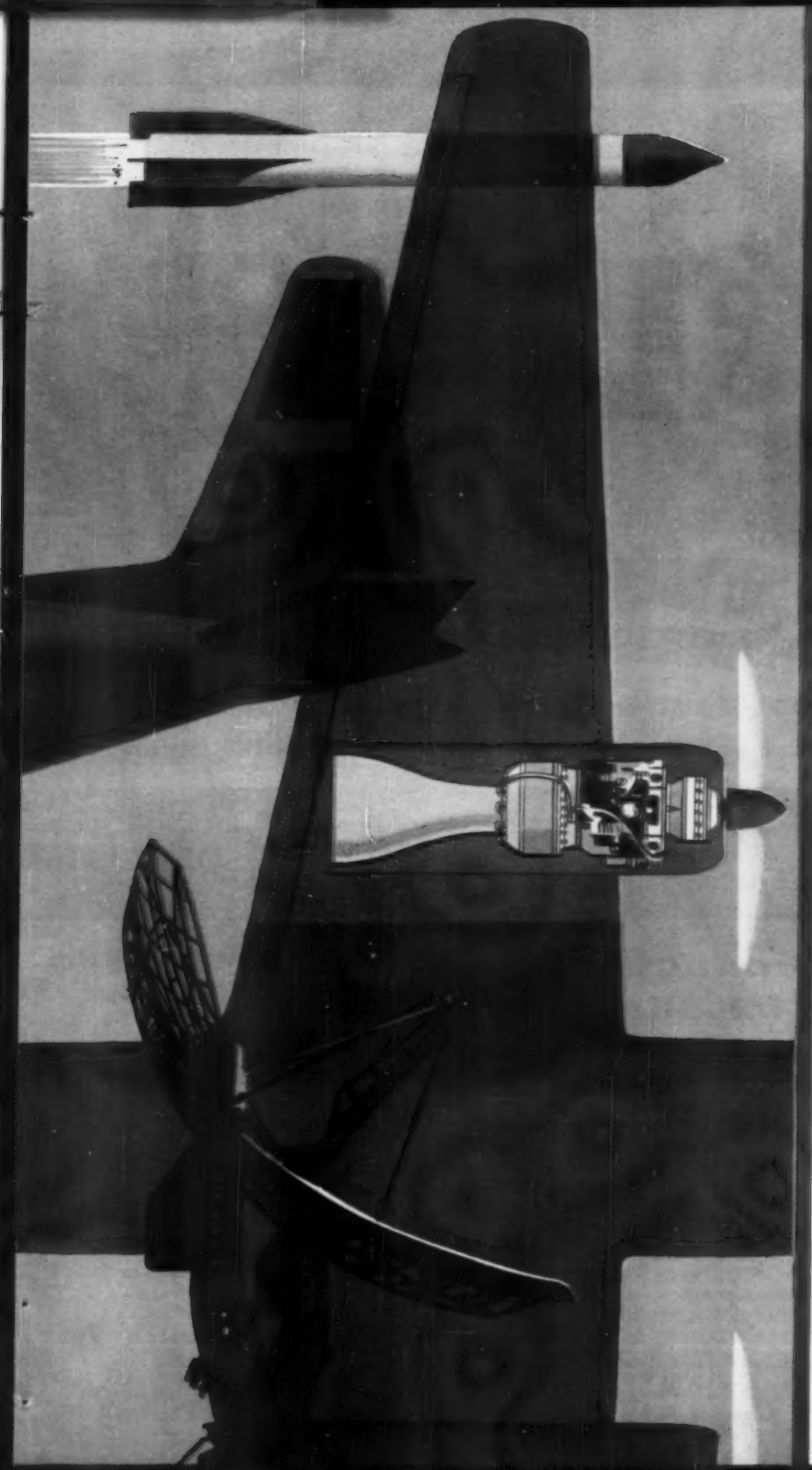
Circle Number 32 on Reader-Service Card

Avco today



Avco makes things better for America

Avco is a builder of quality products for the commercial economy and high-performance military systems for national defense. Gas turbine and reciprocating aircraft engines, electronics systems, farm implements, kitchen components and the Nose Cone for the Air Force Titan Intercontinental Ballistic Missiles are being produced by Avco *today*.

There are many products that identify Avco. All of them display distinguishing characteristics of Avco workmanship . . . skill, dependability, resourcefulness. And Avco's first order of business is to make things better for America.

THIS IS AVCO

Avco today is a diversified organization whose products include aircraft power plants and structures, electronics for defense and industry, and specialized home and farm equipment.

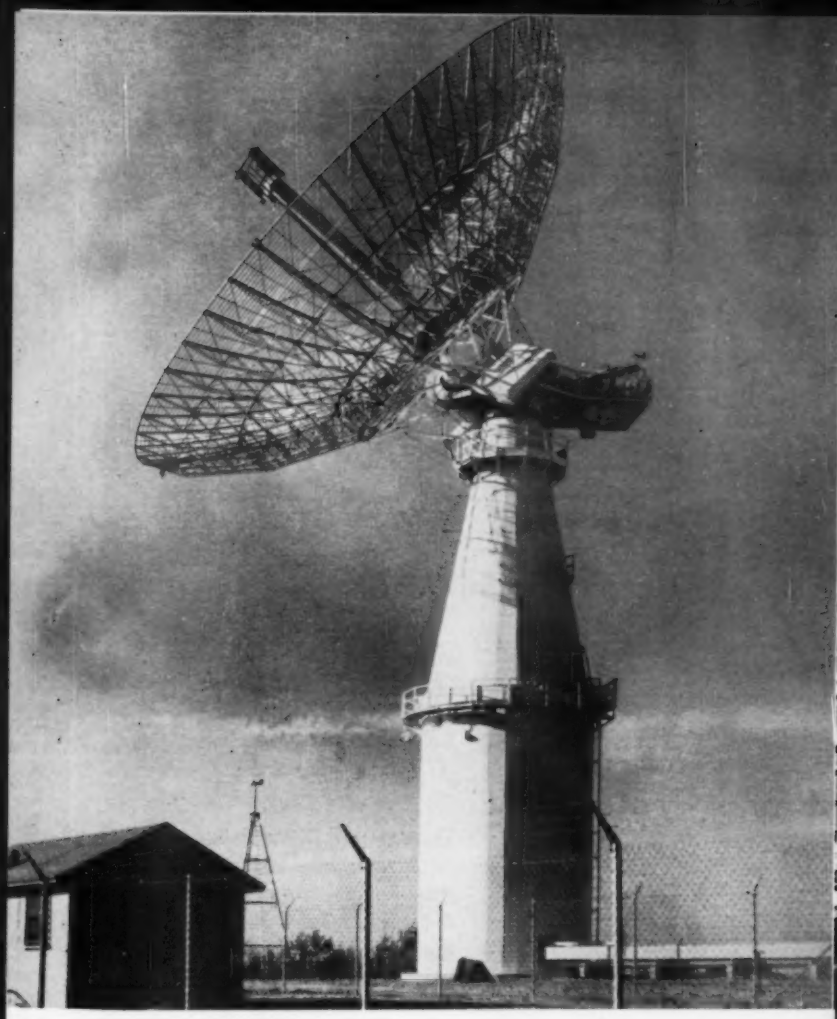
Avco's divisions and subsidiaries are:

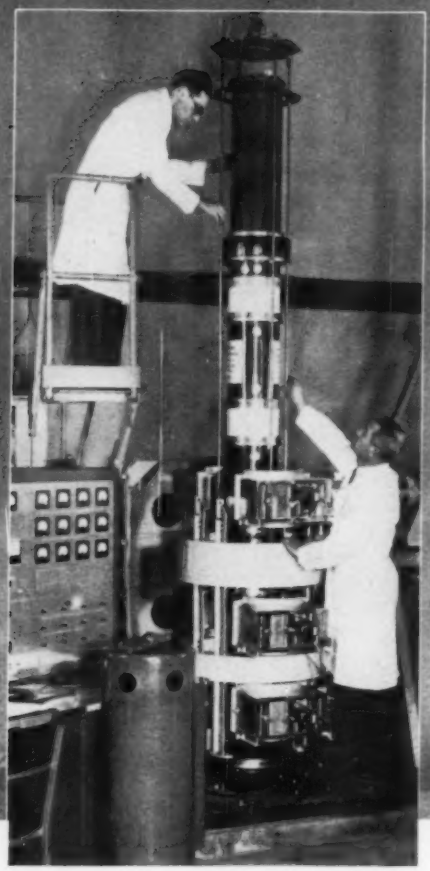
Lycoming—aviation, marine and industrial power plants . . . Crosley—electronics systems and aircraft structures . . . Research and Advanced Development . . . American Kitchens . . . New Idea and Ezee Flow—specialized farm equipment . . . Crosley Broadcasting Corporation . . . Moffats Limited (Canada)—commercial gas and heating equipment.

Avco makes things better for America

Avco

Avco Manufacturing Corporation
420 Lexington Avenue, New York, N. Y.





Eimac super-power klystron being lowered into circuitry in Eimac laboratory.

Eimac Klystron Produces Super Power For Missile Tracker

Development of the super-powered radar ballistic missile tracker, now in operation at the Lincoln Laboratory of Massachusetts Institute of Technology, required an electron tube that would produce tremendous amounts of RF energy at the desired frequency. Long experience in pioneering ceramic-metal power klystrons enabled Eimac to design a super klystron that efficiently and reliably produces the tremendous RF pulse power required for this application. It was built for Continental Electronics Manufacturing Company, the transmitter manufacturer, under sponsorship of the Air Research and Development Command's Rome Air Development Center of the United States Air Force.

Similar to the tube shown above, this super klystron is the largest electron tube in the world; even this ten-foot giant will soon be dwarfed by 17-foot Eimac klystrons now under development.

Equipment engineers throughout the world are finding that the uniqueness of Eimac klystrons makes the difference in simple, efficient and reliable equipment design for tropospheric scatter, commercial television, telephone relay and high power radar applications. Eimac today manufactures CW and pulse amplifier klystrons covering the spectrum into the X Band and to megawatts of power.

For further information on Eimac klystrons write our Application Engineering Department for a copy of Klystron Facts Case 4

EITEL-McCULLOUGH, INC.
SAN BRUNO, CALIFORNIA

Eimac First for high power amplifier klystrons

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Products Designed and Manufactured by Eimac

Negative Grid Tubes
Reflex and Amplifier Klystrons
Ceramic Receiving Tubes
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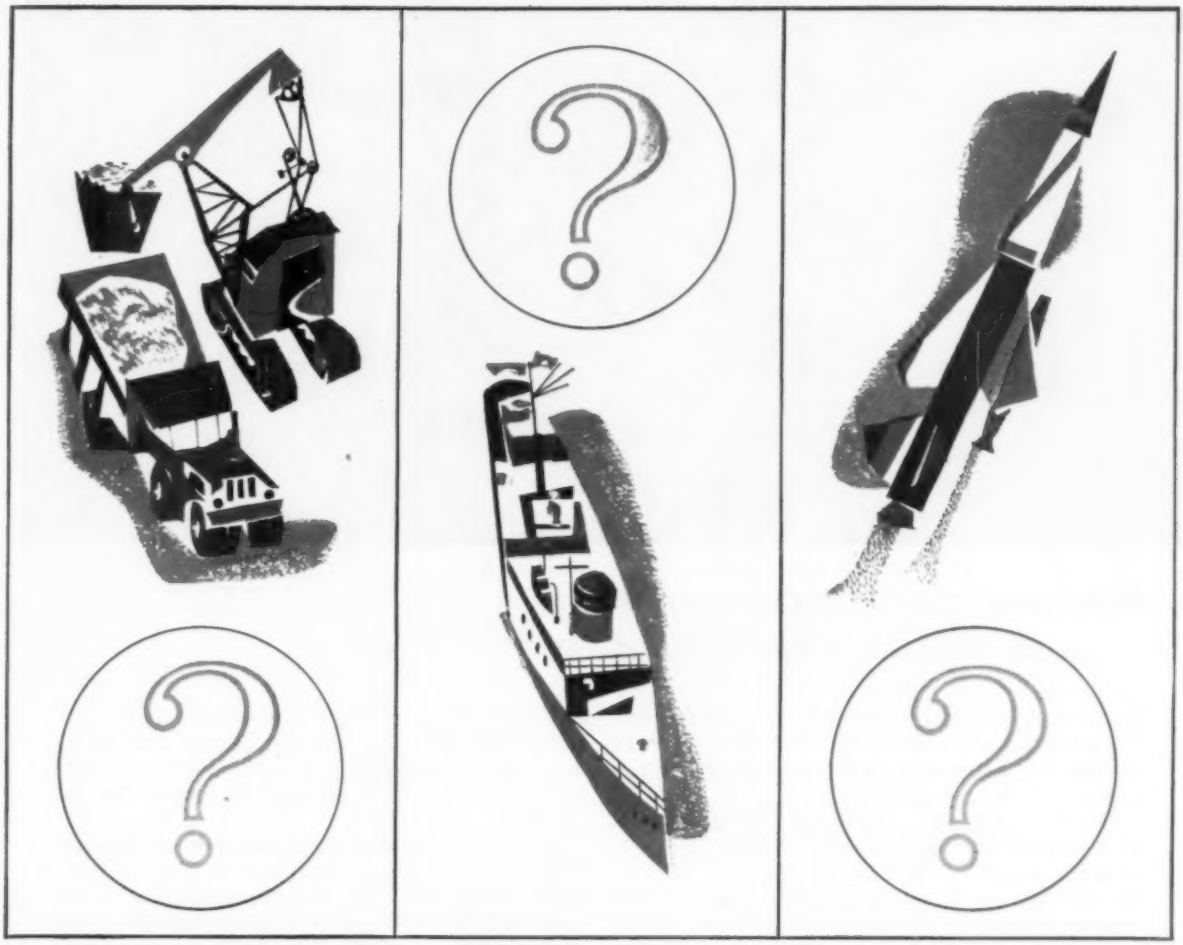
Includes the most extensive line of ceramic electron tubes

are you looking for switches controlled by speed



AC-Milwaukee now produces a speed sensing switch so sensitive that it operates, and continues to operate, within ½ of 1% of turbine speeds ranging from 500 to 4600 rpm. If you need to control from one to four engine functions in relation to turbine speeds, AC has the answer. This speed sensing switch has proved itself in thousands of operational hours on military jet aircraft . . . controlling ignition systems and afterburners in flight.

The AC Speed Sensing Control weighs about four pounds and is compact enough to be mounted almost anywhere. It holds calibration even when subjected to high engine vibration . . . can operate without servicing for periods up to those recommended for jet engine overhaul.

For help in solving any problem related to automatic control of electrical switching operations, call AC-Milwaukee.

If you are an engineer with a mechanical, electronic or electrical background, and would like to work with AC's Milwaukee group, write Mr. Cecil Sundeen, Supervisor of Technical Employment, Dept. K, 1925 D. Kenilworth, Milwaukee 1, Wisconsin.

AC SPARK PLUG ⚛ THE ELECTRONICS DIVISION OF GENERAL MOTORS

Inertial Guidance Systems • Afterburner Fuel Controls • Bombing Navigational Computers • Emergency Fuel Controls
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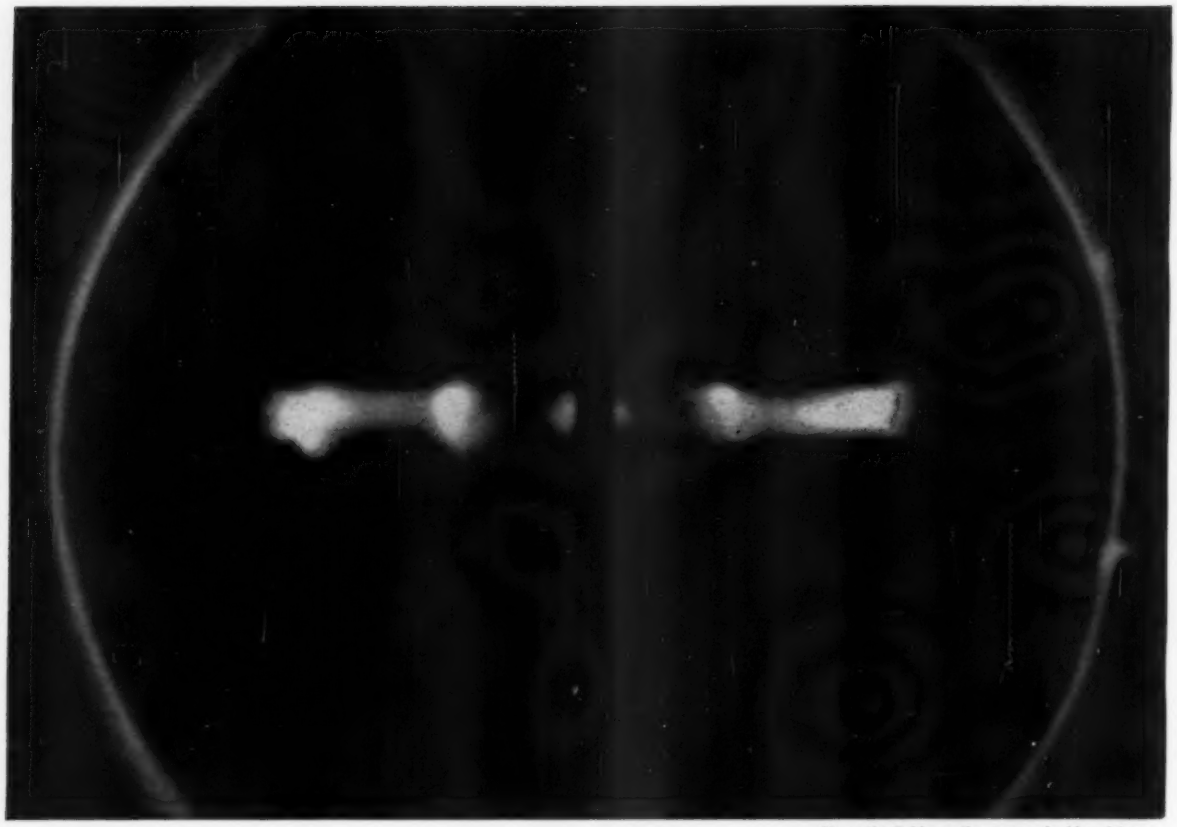

Magnetic fields, acting as a double piston, drive luminous ionized shock waves through transparent tube. One-tenth microsecond exposure in STL's Physical Research Laboratory.

MAGNETOHYDRODYNAMICS and SPACE TECHNOLOGY

Magnetohydrodynamics provides one of the most promising approaches for attaining the velocities and specific impulses that will be required for manned space flight to a planet, landing, and returning.

The critical problem in attaining velocities of hundreds of thousands of miles per hour is the containment of temperatures comparable to those in the interior of stars. Because the temperature of the driving reaction will have to rise as the square of the exhaust velocity, temperatures greater than one million degrees will be encountered in reaction chambers. Magnetohydrodynamics offers a unique solution to the basic problem of containing the reaction without contact with the chamber walls.

Briefly, the physical principles of magnetohydrodynamics are these. Since gas at such temperatures is completely ionized and is an effective conductor of electricity, the introduction of currents in the gas (in this state called a plasma) creates an electromagnetic field. This field makes it possible to control the plasma by applying an external opposing magnetic field which creates a magnetic bottle to contain the charged gas particles. Similarly, a magnetic-field piston can be used to accelerate the particles. Such magnetohydrodynamic reactions are expected to develop exhaust velocities that are an order of magnitude greater than those generated by present chemical rockets.

At Space Technology Laboratories, both analytical and laboratory work are proceeding in the field of magnetohydrodynamics. This work illustrates the advanced research in STL's Physical Research Laboratory, which emphasizes the application of basic physical principles to the requirements of space technology.

In support of its over-all systems engineering responsibility for the Air Force Ballistic Missile programs, and in anticipation of future system requirements, STL is engaged in a wide variety of research and experimental development activity. Projects are in progress in electronics, aerodynamics, propulsion, and structures.

The scope of work at Space Technology Laboratories requires a staff of unusual technical breadth and competence. Inquiries regarding the many opportunities on the Technical Staff are invited.

SPACE TECHNOLOGY LABORATORIES

A Division of The Ramo-Wooldridge Corporation

5730 ARBOR VITAE STREET • LOS ANGELES 45, CALIFORNIA

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Fafnir presents a **NEW** *series of*

MINIATURE BALL BEARINGS

featuring

1. *Vacuum melt 440C stainless steel*
2. *Balanced design*
3. *Precision tolerances*

Fafnir now offers a series of miniature ball bearings, fabricated entirely of extra clean vacuum melt 440C stainless steel. This steel has a minimum of impurities and eliminates the chances of pits and imperfections in the races.

Because of superior race finish, the ultimate results are supersensitive bearings with low torque values. The balanced construction results from separate retainers for each bearing size. Thus the pitch circle of the balls is centered between the bore and outside diameter.

Made to ABEC-5 tolerances or better, these bearings are engineered for precision instrument applications where performance and long life are vital.

Fafnir's instrument bearing division has been expanded for production of the new miniature series. These bearings are made in the world's cleanest metalworking area, regarded as a model throughout industry.

Investigate this new series of precision miniature bearings. Write for bulletin to The Fafnir Bearing Company, New Britain, Conn.

Fafnir's Precision Miniature Bearings Series currently includes four design variations available in each size.
Open Type • Two Shields
Flanged Type • Flanged Two Shields

FAFNIR
BALL BEARINGS

Circle Number 36 on Reader-Service Card

ONE OF THE GARLOCK 2,000

Model 47J Bell Helicopter

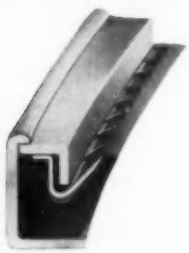
Garlock KLOZURES* Specified on Bell Helicopters for 10 years

Since 1947 Bell Helicopter Corporation engineers have consistently specified Garlock KLOZURE Oil Seals for twelve different sealing functions. These KLOZURES serve in both low speed and high speed capacities contributing in no small measure to the outstanding performance and leadership of Bell Helicopters in that industry. Bell reports these seals have a minimum satisfactory life exceeding the required 600 hour overhaul.

The standard sealing element in a Garlock KLOZURE Oil Seal is a unique synthetic material molded to very accurate dimensions. It is non-abrasive, free-running; resistant to oil, grease, heat, and cold; impervious to water, mild acids, and alkalies. It is also extremely durable and resilient. For unusual service requirements sealing elements made of silicone rubber for temperature extremes or Teflon for resisting strong acids and other chemicals can be obtained.

A long list of satisfied users is added assurance that Garlock KLOZURES provide trouble-free bearing protection . . . sealing-in lubricants . . . sealing out abrasive dust and dirt. If you have a sealing problem, why not ask your Garlock representative for his recommendation from "The Garlock 2,000" . . . two thousand different styles of packings, gaskets, and seals for every need. The only complete line in the industry.

*Registered Trade Mark



Cross-section of Model 51 Garlock KLOZURE Oil Seal designed for medium-speed rotary service and low pressure reciprocating service. This seal is used in the Transmission Assembly and in the Tail Rotor Gear Box of the 47J Bell Helicopter.

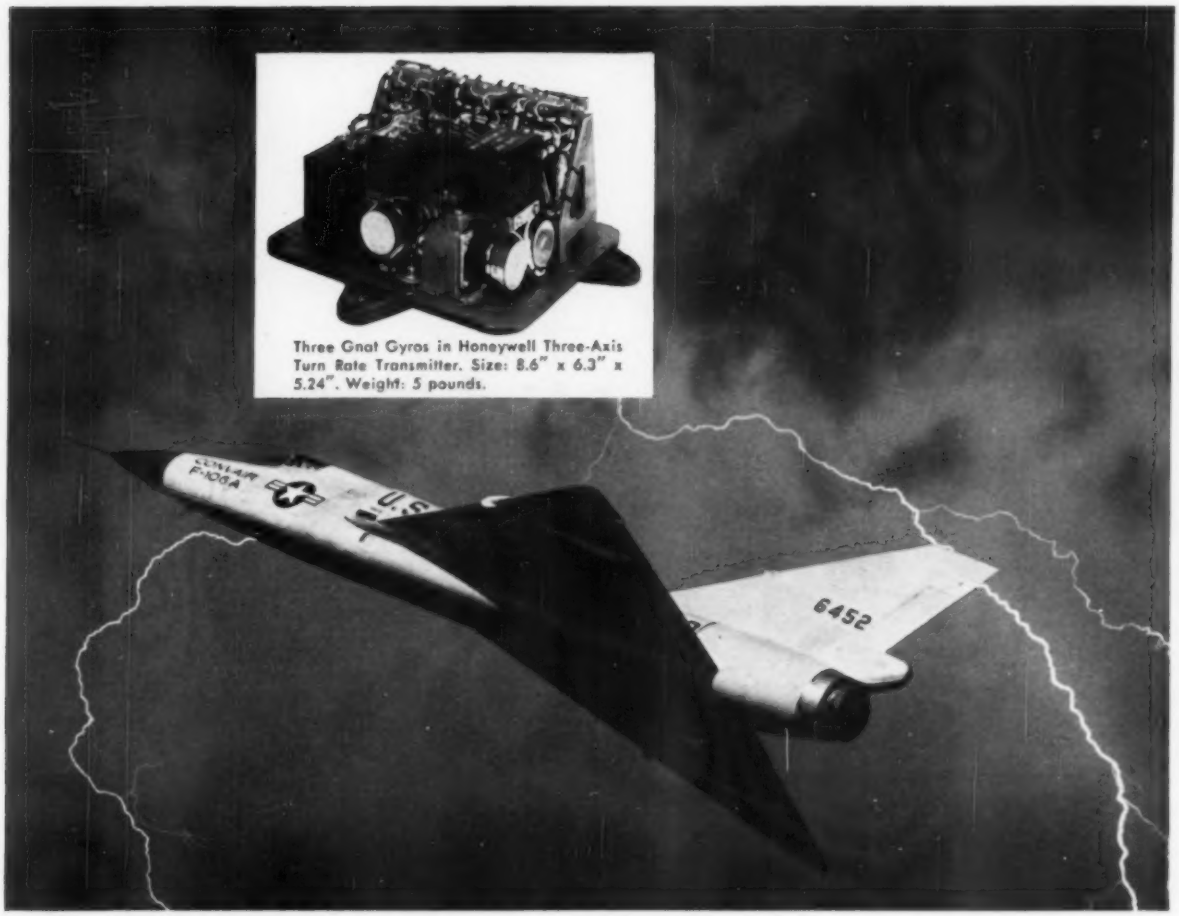
WRITE on company letterhead for new KLOZURE Catalog 20. 79 pages of helpful information on oil and grease seals for bearings.

THE GARLOCK PACKING COMPANY, Palmyra, New York

For Prompt Service, contact one of our 30 sales offices and warehouses throughout the U.S. and Canada.

GARLOCK

Packings, Gaskets, Oil Seals, Mechanical Seals, Rubber Expansion Joints, Fluorocarbon Products



Convair F-106 all-weather jet interceptor incorporates Honeywell Three-Axis Turn Rate Transmitter in flight control damper system

Three-axis control at *all* speeds and altitudes

Gnat Rate Gyro shown ⅔ size. Weight: 3.8 ounces.

The Honeywell Three-Axis Turn Rate Transmitter, featuring three Gnat miniaturized gyros, was selected for the new Convair F-106 "Delta Dart" all-weather jet interceptor. Built into the stability augmentation sub-system of the jet's flight control system, the Transmitter detects rate of turn about the yaw, pitch and roll axes and responds with an output signal whose voltage is proportional to these input rates of turn.

This system is designed to operate under the most severe environmental conditions to which a combat aircraft might be subjected. The Honeywell Gnat Rate Gyros are easily capable of withstanding the severe shock, vibration and temperature requirements of this application and as such are mounted directly upon the base casting without shock mounts to optimize dynamic characteristics of the system.

The electronic portion of the Turn Rate Transmitter amplifies and demodulates the Gyro output signals to provide polarity reversing d-c outputs proportional to the corresponding input rate to each Gyro.

Investigate Honeywell's ability to develop, engineer and produce flight control systems for today's most advanced aircraft and missiles. Write for Bulletin GN to Minneapolis-Honeywell, Boston Division, Dept. 11, 1400 Soldiers Field Road, Boston 35, Mass.

Honeywell H HONEYWELL

Boston Division

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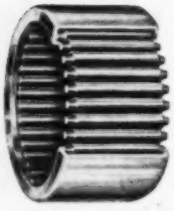
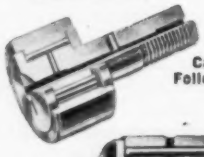
Circle Number 37 on Reader-Service Card

In the Marines' newest "skyhooks," Kaman HOK-1 Helicopters, Torrington Cam Followers and Type DC Needle Bearings are used in the control system for compactness, and Type NBC Needle Bearings are used in rotor hubs for high load capacity.



Needle Bearings



Cam Followers

TYPE NBC

Helping put the lift in "skyhook"

In helicopters, lower weight means greater load lifting ability. Kaman Aircraft Corporation achieves this with extensive use of Torrington Needle Bearings in HOK-1 Helicopters.

The nine Needle Bearing Cam Followers and 22 Type DC Needle Bearings in the control system provide high capacity in minimum space. They also allow for the compactness and light weight of other adjacent components. Six NBC Needle Bearings provide high load capacity in the lead-lag pivots and the teeter pivot where dependable anti-friction operation is essential. These high capacity bearings support the helicopter.

Torrington Needle Bearings have found extensive use in modern aircraft where minimum weight and maximum capacity are so vital. Torrington offers engineering assistance based on its extensive experience with aircraft applications to help you improve the performance and reliability of your equipment. **The Torrington Company, Torrington, Conn.—and South Bend 21, Ind.**

TORRINGTON BEARINGS

District Offices and Distributors in Principal Cities of United States and Canada

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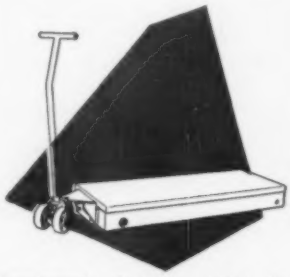
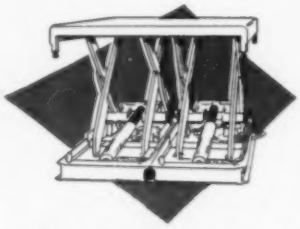
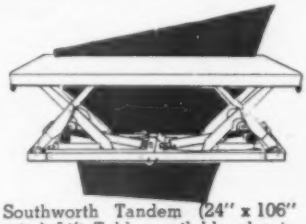


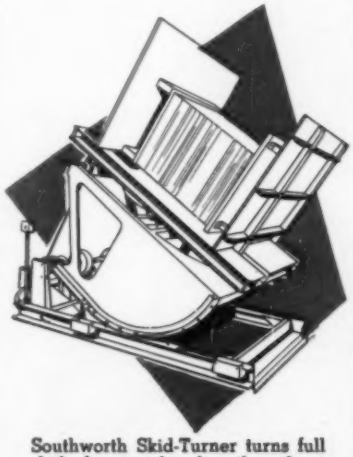
Southworth Portable 2000 lb. Lift Table shown collapsed with dolly. Can be used to shift light loads on short hauls. No installation cost. Simply plug it in.



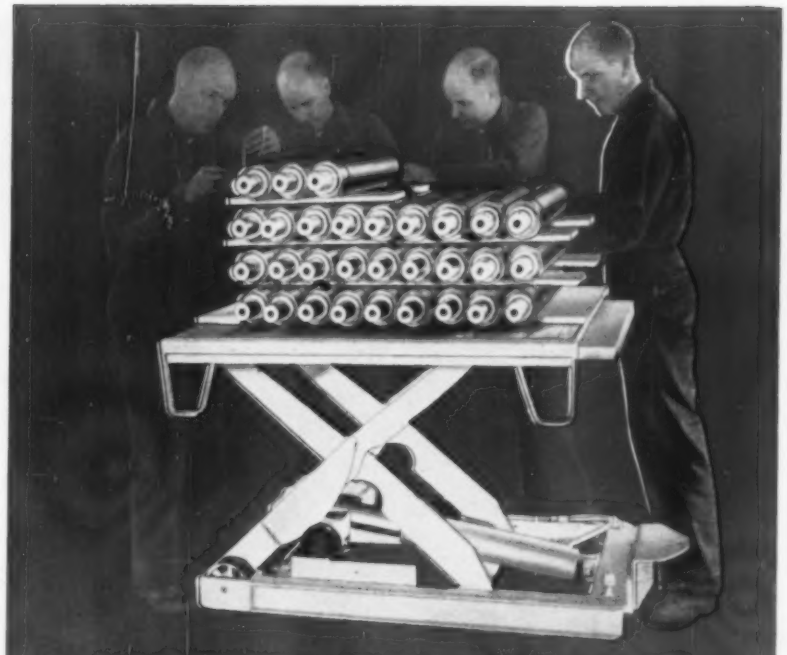
Southworth Twin (48" x 53" min.) Lift Tables available in varying capacities up to 24,000 lbs. Hinged platform makes servicing easy in totally collapsed position.



Southworth Tandem (24" x 106" min.) Lift Table available also in capacities up to 24,000 lbs. Note entirely self-contained pump assembly and working parts.



Southworth Skid-Turner turns full skid of material in less than three minutes. One man operated. Push button control. Capacity 5,000 lbs.



UP OR DOWN, WORK ALL AROUND

There's no superstructure to a Southworth!

One of the more conspicuous advantages of a Southworth Lift Table is the absence of any superstructure. Furthermore, the motor and pump assembly is completely self-contained. Consequently, the operator finds absolutely *no* hindrance to approaching his work load from any angle, at any level, at any time.

Less obvious, but of equal importance, is the opportunity so presented for positioning the portable model with either end or either side at the machine it serves. For permanent recessed installations only a shallow pit equal in depth to the low collapsed height of the Table is needed, the flush top actually becoming a part of the floor.

Whatever your industry you'll find, as hundreds already have, that this versatile hydraulic powered scissor-type Lift Table ably fulfills its promise to both methods men and cost accountants.

BASIC SPECIFICATIONS

Capacities:	2000 lbs.	4000 lbs.	6000 lbs. 8000 lbs.
Platform Size (Min.)	19½" x 53"	24" x 53"	30" x 60"
Collapsed Height	6"	7"	8"
Extended Height	36"	37"	40"
Controls	Foot or Hand Switch		
Motors	Single phase on Standard Models		
Hydraulics	Pump actuated ram with relief and solenoid valves.		

Larger, or special purpose, platforms available on all standard models. Greater vertical platform travel also available in a variety of capacities. Write for specifications on these and on other tables with capacities up to 24,000 lbs.

For Further Details Write:

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Manufacturers of Paper Conditioners; Automatic Skid Lifts; Skid Turners; Hand, Foot, Motor Driven Punching Machines; Humidifiers; Envelope Presses; Punch Heads; Tabbing Knives and Corner Cutters plus Custom Built Equipment.

ELIMINATE FATIGUE • REDUCE HANDLING TIME • INCREASE PRODUCTION

Our biggest asset can't be photographed

What's inside this engineer-scientist's head? A camera won't reveal that for 30 years a trained mind has been accumulating a vast fund of knowledge on gyroscopes and has come forth with sound original thinking on inertial guidance.

No photograph can tell that another man thoroughly grasps the present state of the art in infrared technology and has creative ideas for the future.

We can't show pictorially the knowledge and reasoning ability other staff members bring to such subjects as radar, general electronics, semi-conductors, computation, mechanical design, and all the other fields of competence that go to make up a balanced research and development facility.

Nor can we show the special types of gray matter that make a first class systems engineer, a top production man, or a forward-looking executive to keep these specialists functioning smoothly as an integrated organization.

But we can tell you what these people have done in the past, what they are doing now (where military security permits), and what we believe they can do for you. Write Dept AW, Mechanical Div., General Mills, 1620 Central Ave., Minneapolis 13, Minn.

MECHANICAL DIVISION

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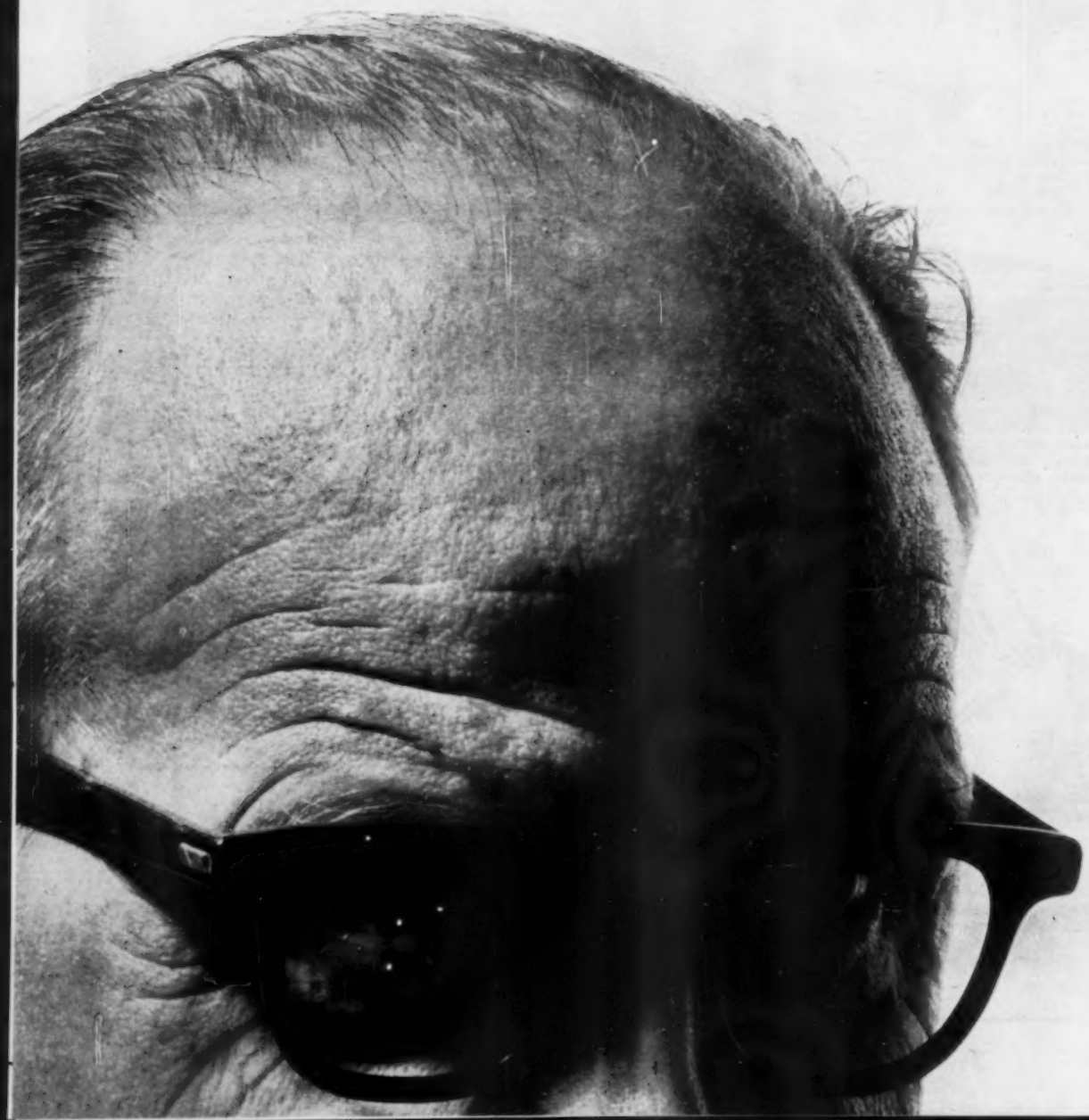
General Mills



VA-210B

FOR RADAR
RECEIVERS

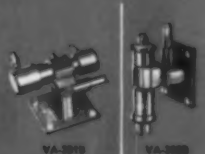
VARIAN KLYSTRONS

HIGH FREQUENCY STABILITY, RUGGED CONSTRUCTION, LONG LIFE

SEE US AT THE I. R. E.
BOOTHS NOS. 2911-13-15

The new VA-210B Klystron is a super-rugged oscillator, engineered to give long, reliable service under severe operating conditions. Frequency is extremely stable, even under conditions of the most severe shock, vibration and temperature variation. Features include a unique brazed-on external tuning cavity, a very rugged, quick-heating cathode, a slow-rate non-microphonic tuner and an all metal and ceramic construction.

Varian makes a wide variety of Klystrons and Wave Tubes for use in Radar, Communications, Tests and Instrumentation, and for Severe Environmental Service Applications. Over 100 are described and pictured in our new catalog. Write for your copy.



VARIAN associates
TUBE DIVISION
PALO ALTO 32, CALIFORNIA
Representatives throughout the world

VA-210B	9.6 to 10.0 kMc	30 mW
VA-201C	8.5 to 9.6 kMc	90 mW
VA-213B	8.5 to 9.6 kMc	30 mW
VA-24	16.5 to 17.5 kMc	40 mW
VA-221H	5.25 to 8.50 kMc	40 mW

KLYSTRONS, TRAVELING WAVE TUBES, BACKWARD WAVE OSCILLATORS, LINEAR ACCELERATORS, MICROWAVE SYSTEM COMPONENTS, E. P. SPECTROMETERS, MAGNETS, MAGNETOMETERS, KLYSTRONS, POWER AMPLIFIERS, GRAPHIC RECORDERS, RESEARCH AND DEVELOPMENT SERVICES

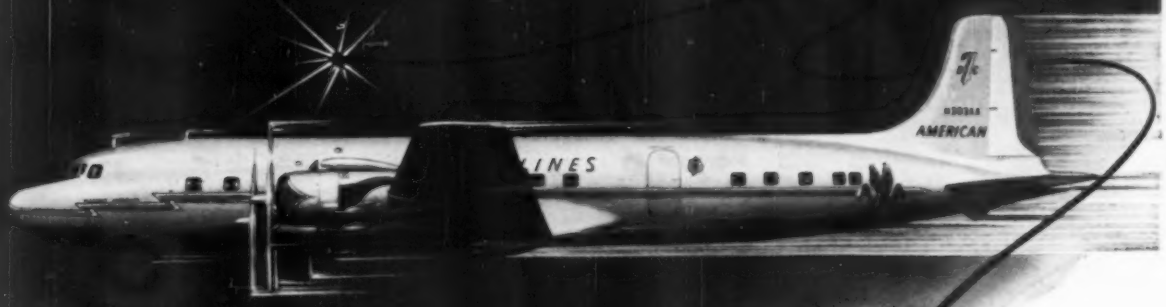
U.S. AIR FORCE
CONTROL TOWER LOG
0823 White Fox Leader taxis runway 18 for takeoff with flight of four.
0830 White Fox Leader flame out on takeoff. Crash lands 2 mi south of runway 18. Crash rescue crew in H-43 dispatched immediately.
0837 Helicopter pilot reports White Fox Leader rescued from crash with minor burns. Evacuated to Base Hospital.
0840 H-43 rescue helicopter back on standby status
0903 C-124 56-1279 requests landing instructions

THE *KAMAN* AIRCRAFT CORPORATION

BLOOMFIELD, CONNECTICUT

Circle Number 43 on Reader-Service Card

Coast-to-Coast... on The Royal Coachman



. . . and Sinclair helps American spare the horses!

Getting there in a hurry is only half the story behind the success of American's "Royal Coachman." Further facts– this DC-7 nonstop flight offers true luxury features at aircoach fares–seats may be reserved upon ticket purchase and an economical meal bought for service aloft. There's even a passenger lounge for relaxation.

But even more important to American is the reliability of its equipment. That's why American uses Sinclair Aircraft Oils exclusively. They give maximum protection against engine heat and friction.

45% of the oil used by major scheduled airlines in the U. S. is supplied by Sinclair. You, too, can place your confidence in Sinclair Aircraft Oil.

SINCLAIR AIRCRAFT OILS

Sinclair Refining Company, Aviation Sales, 600 Fifth Avenue, New York 20, N. Y.

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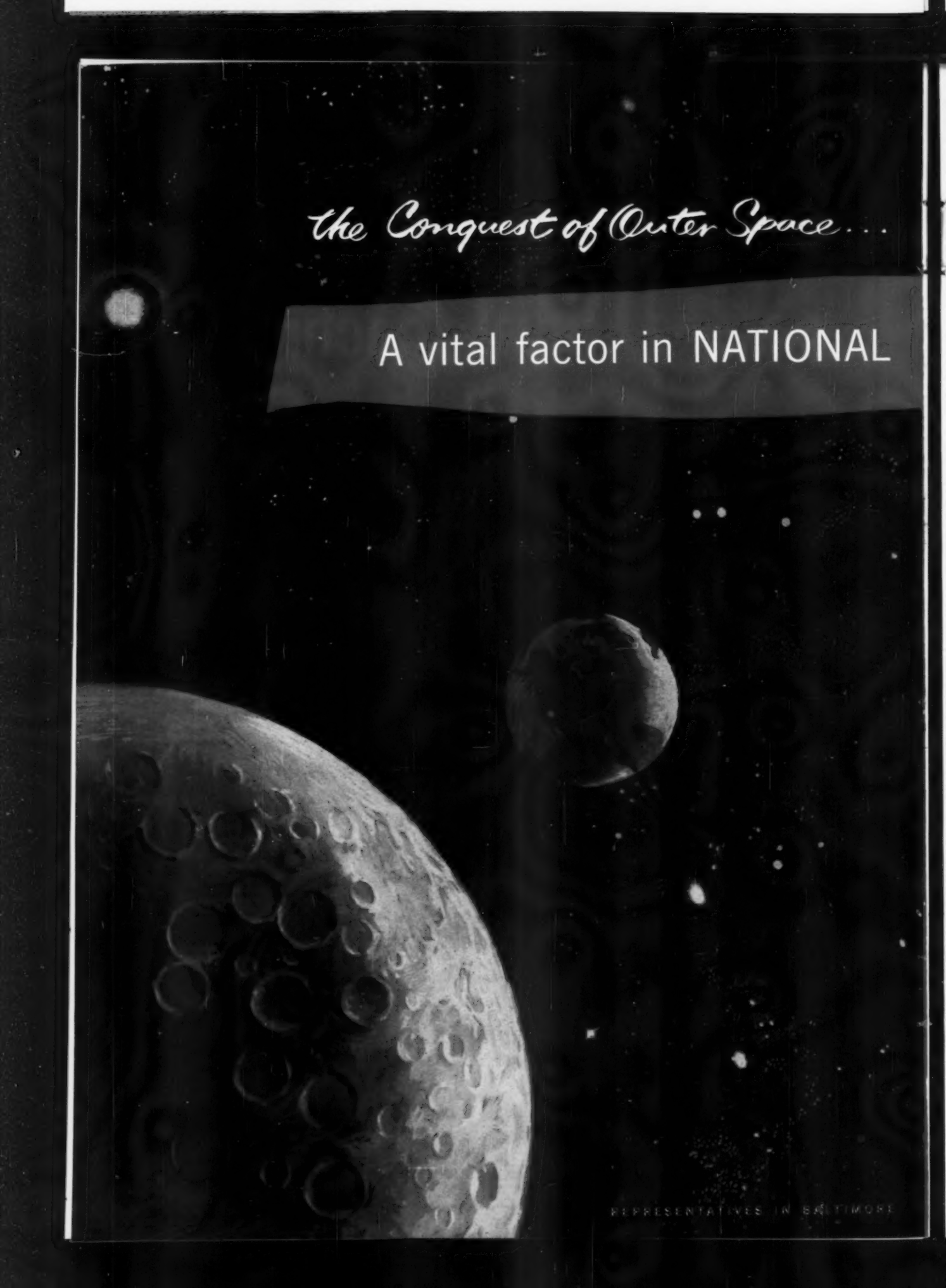
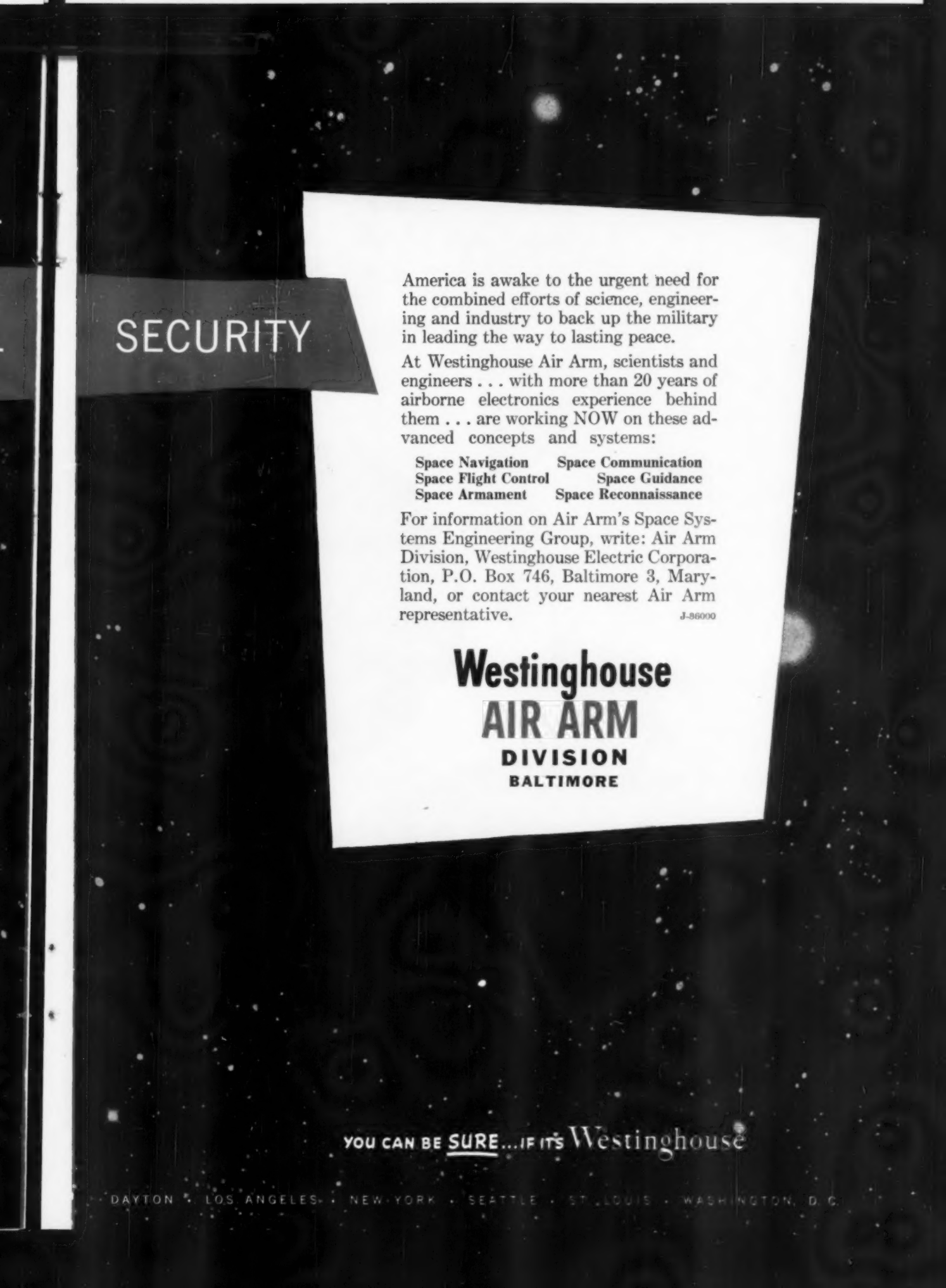

the Conquest of Outer Space . . .
A vital factor in NATIONAL
REPRESENTATIVES IN BALTIMORE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America is awake to the urgent need for the combined efforts of science, engineering and industry to back up the military in leading the way to lasting peace.
At Westinghouse Air Arm, scientists and engineers . . . with more than 20 years of airborne electronics experience behind them . . . are working NOW on these advanced concepts and systems:
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Five stories up a painter puts the finishing touch on one of Pan Am's "Super-7" Clippers—America's fastest airliners.

Skymark of Experience ...the world over

Spring has come a little early at Pan American this year. All over the world we're being decked out in our newest finery.

Our designers have called the shots. Our painters are painting. Our fashion experts are hard at work. The famous "winged world" symbol of Pan American and the traditional Pan Am blue color have been streamlined to a stylized sphere of the world and a lighter sky-blue color. The familiar wind-swept Pan American lettering has been replaced with a modern, distinctive block style.

You'll see our new insignia and color on Pan Am Clippers* and ground equipment, on our windows and on the windows of our appointed Travel Agents, on our timetables, at our ticket counters and on all Pan Am advertising and promotional material. It's the new high sign of the times. The new mark of historic leadership in the air and on the ground in 82 lands on 6 continents the world over.

Wherever in the world you're going, you'll see Pan Am's new skymark. It's easy to spot. It's a quick way to tell that you're with the World's Most Experienced Airline. Look for it.

This year well over a million happy people will go overseas by air. Just one of the reasons will be Pan Am's new economy-class Thrift Fares to Europe starting April 1st.†

†SUBJECT TO GOVERNMENT APPROVALS *TRADE-MARK, REG. U. S. PAT. OFF.

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WORLD'S MOST EXPERIENCED AIRLINE

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PLANE FAX

by STANDARD OIL COMPANY OF CALIFORNIA

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So, if you're like the many other flyers who have discovered through experience that regular service with Chevron and RPM Aviation Products gives planes more pep and power, you'll want this new credit card. It's flight-weight in a handy size to fit your wallet. You can apply for it simply by mailing the coupon below. And for safer, more enjoyable flying, for business or pleasure, make it S.O.P. to use Chevron and RPM Aviation Products every time.

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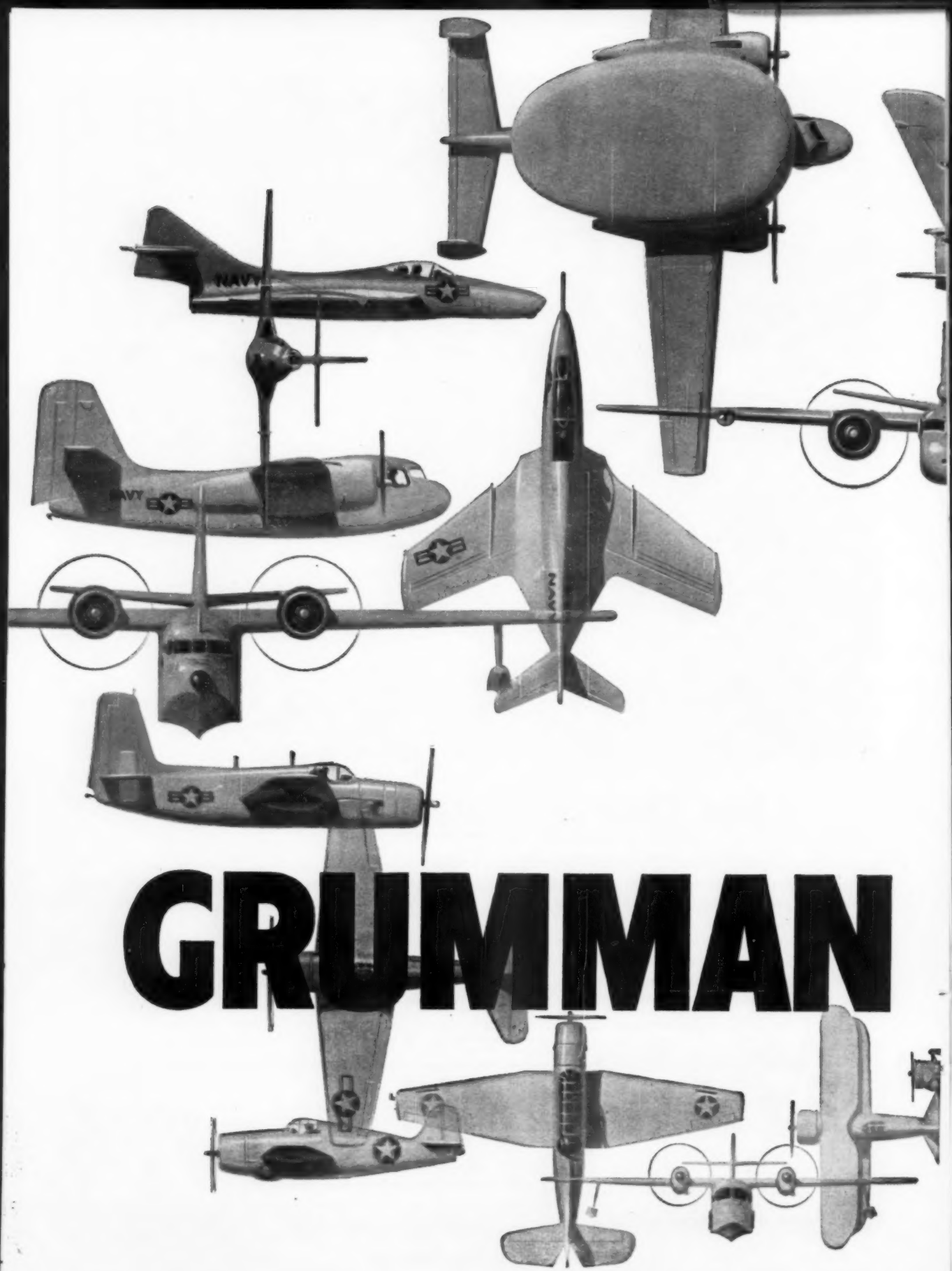
☐ Please send application blank for new aviation credit card.

☐ I have Standard Oil Company of California automotive credit card number _____. Please send me an aviation credit card.

NAME _____ ADDRESS _____

CITY _____ ZONE ____ STATE _____



GRUMMAN

Sum total: 27 years. With many firsts along the way. The first military plane with retractable landing gear. The first carrier-based aircraft with folding wings. First swept-wing jets on operational service with carrier squadrons. First in the air with area-rule (coke bottle) fuselage for fighters. The first aircraft capable of performing the complete search-attack mission against subs. First in amphibians with the production of more such craft than the rest of the world combined. First with two-place transonic jet fighter-trainers.

Sum total: more than 24,000 planes. Ready in quantity when needed. At minimum cost to our government. And backed by unexcelled operational and maintenance field support throughout the world. Small wonder Grumman products have been in uninterrupted service every day of every year since 1930.

EXPERIENCE

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GRUMMAN AIRCRAFT ENGINEERING CORPORATION
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Air Superiority Fighters • Anti-submarine Aircraft • Jet Trainers
Air Transports • Nuclear Research • Aerobilt Truck Bodies
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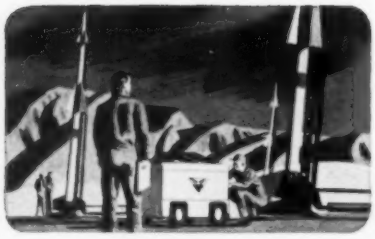
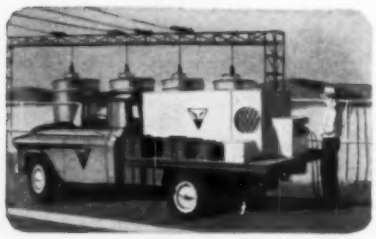
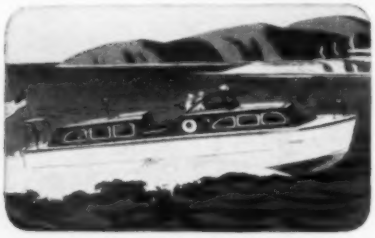


Missile Applications

Ground Support for Jet Aircraft

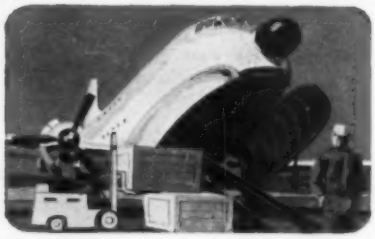


Portable Power Generation

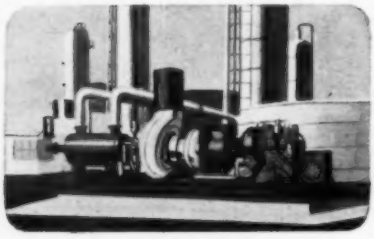


Small Boat Propulsion

Portable Fire Pumps



Auxiliary Power for Aircraft



Turbine Drives for Process Pumps

Power for One-Man Helicopters

Emergency Stand-by Power

Here are nine Solar gas turbine uses! Can you think of more?

SMALL-SIZE SOLAR GAS TURBINES offer a radical new power concept for forward-looking businesses. Their easy portability, high power-to-weight ratio and reliability make them ideally suited for applications beyond the scope of conventional engines. They are easy to maintain, start instantly after long periods of inactivity and can burn a wide variety of fuels—including gasoline, kerosene, diesel oil and others.

Shown above are only nine of the many uses for these new prime movers—and additional applications are limited only by the imagination. To date more than 1000 Solar gas turbines have been sold. They are serving 35 different customers in more than 50 applications. Current production models—the 50 hp Mars® and 500 hp Jupiter®—are being turned out in volume for a growing list of satisfied military and commercial users. And development work on a new 1000 hp Saturn engine is going forward.

For more than a decade Solar has been making important contributions in the gas turbine field. Whatever your business, whatever your special power needs, perhaps a versatile Solar gas turbine can provide the answer. For a new gas turbine brochure, write to Dept. D-162, Solar Aircraft Company, San Diego 12, California. *Designers, developers and manufacturers of gas turbines, expansion joints and aircraft engine, airframe and missile components.*

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ENGINEERS WANTED. Unlimited opportunities, challenging projects, good living with Solar! Write for brochure.

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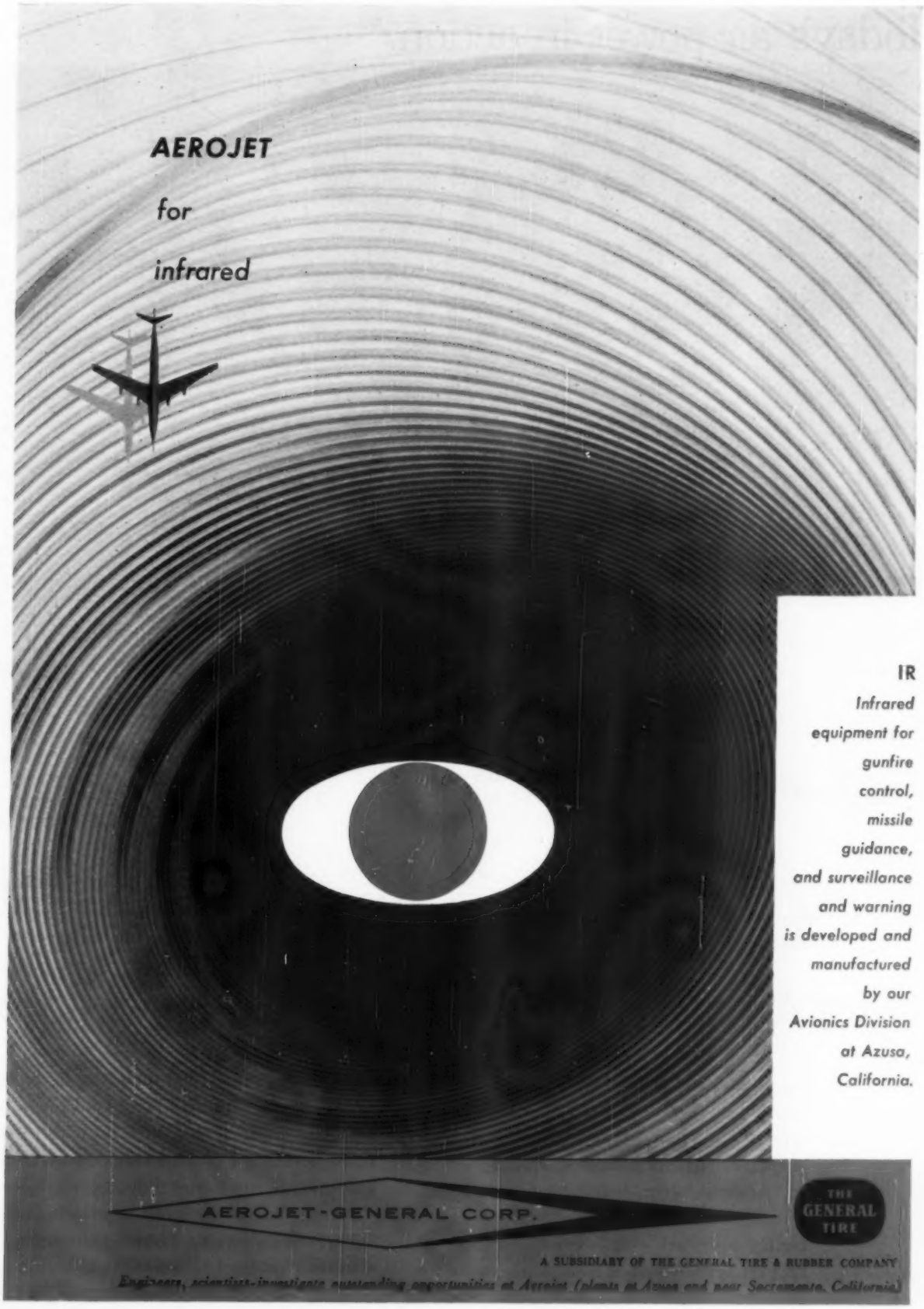

IR

Infrared equipment for gunfire control, missile guidance, and surveillance and warning is developed and manufactured by our Avionics Division at Azusa, California.

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Engineers, scientists—investigate outstanding opportunities at Aerojet (plants at Azusa and near Sacramento, California)

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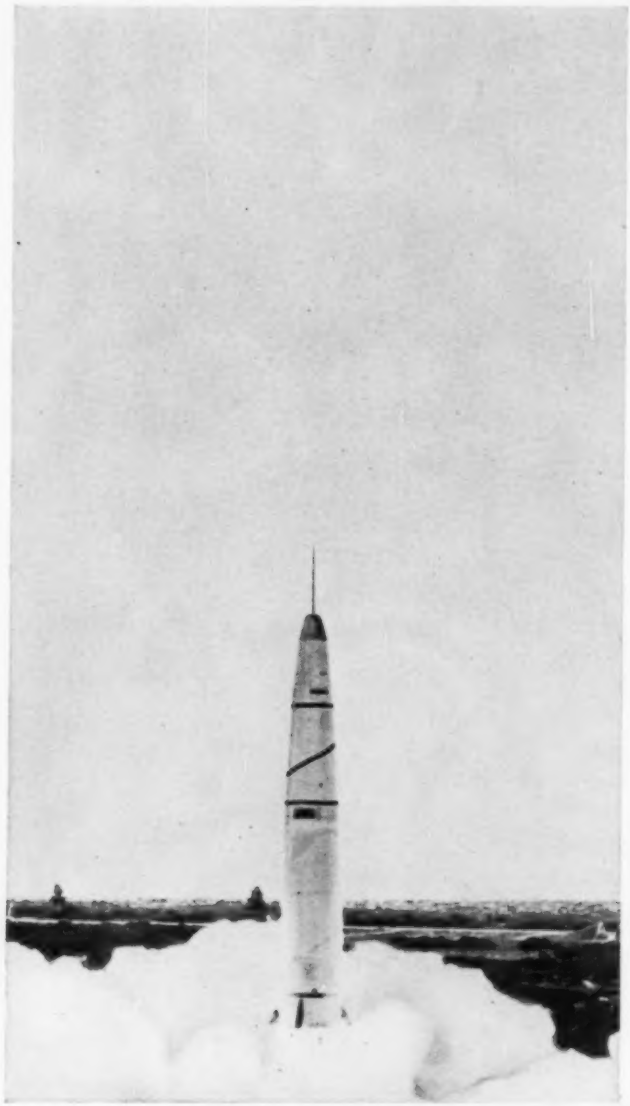
Today's air power in action:*



Thor starting one of its highly successful test flights from Cape Canaveral, Florida.

Giant Air Force THOR — *already in mass production* —

Last November 27th the Defense Department announced that the Douglas *Thor* had been ordered into production as the Air Force's intermediate range ballistics missile.

America's defense is gaining more than just a highly successful missile. *Thor* comes completely equipped with a Douglas-engineered support system that is *immediately* ready for field operation.

No hand-tooled prototype, the *Thor* test models fired for Air Force acceptance are built with mass production tooling. As a result, manufacture of *Thor* on a volume basis began the minute Air Force approval was given.

At the same time the science-industry-military team which cooperated in developing *Thor* readied the important systems required to make it operational... transportation, fuel-

*Defensive systems — The complete air defense must have an attacking arm, too. In the event of an enemy strike, retaliation must be tremendous, decisive, quick. Powerful, accurate intermediate range missiles, like Douglas *Thor*, launched from U.S. bases around the world, provide this potential.

— can strike anywhere in the world from U.S. bases!

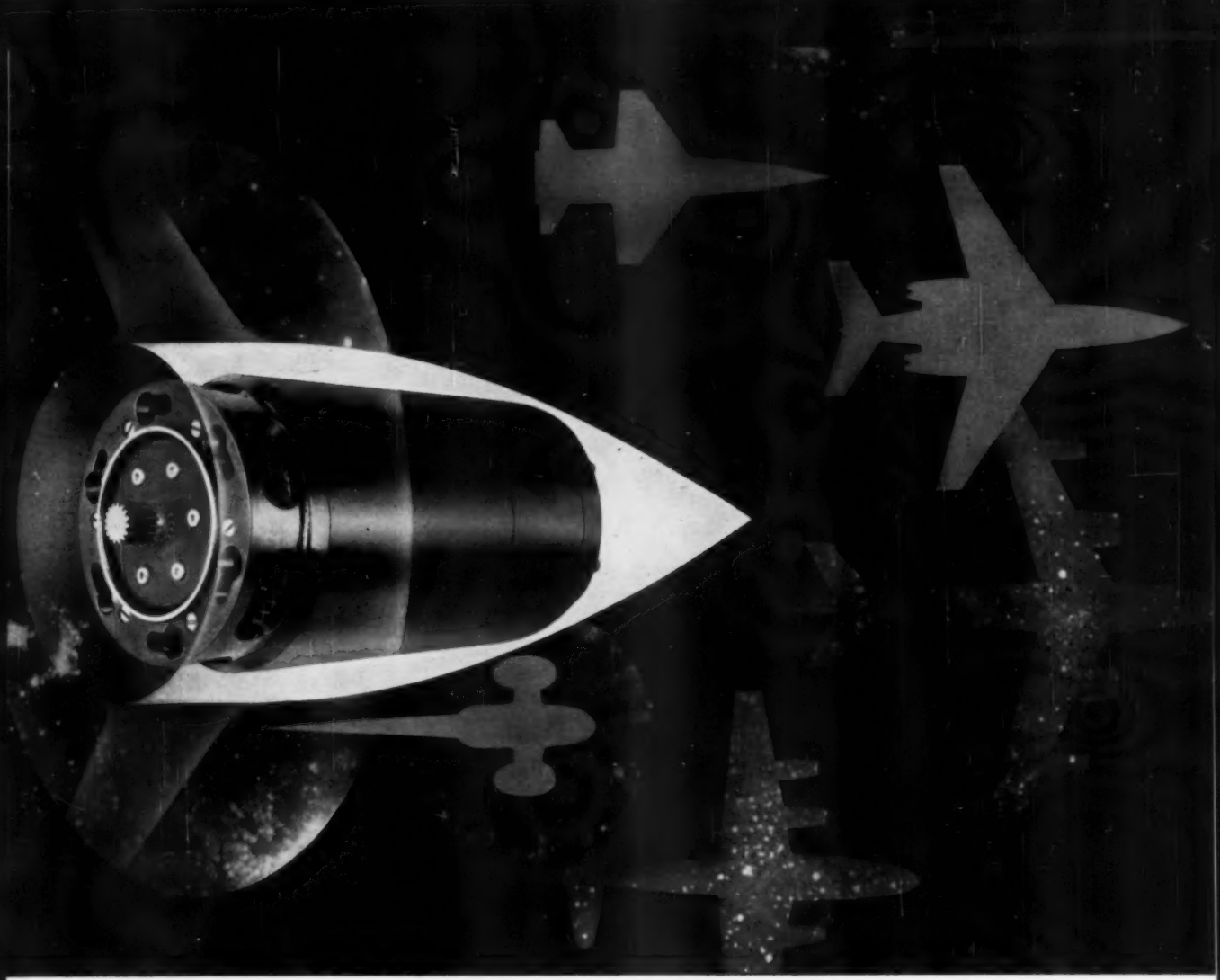
ing, launching, training and parts replacement.

Such thoroughness is typical of Douglas where 19,000 missiles of all types have been produced since 1941. In fact, Douglas is the *only* U.S. manufacturer to have developed missiles systems in all categories...air-to-air, air-to-surface, surface-to-air, and surface-to-surface. And Douglas has an accumulation of missile experience unequaled in the U.S.

Depend on

DOUGLAS

First in Missiles



NEW J & H STARTER-GENERATORS

...power partners of small turbojets

Now, a single, small machine performs *two* important functions—engine starting and power generation—in aircraft and helicopters driven by the newer, small turbojet and turboprop engines. The new units are also ideal for GPUs. Obvious advantages: reduce weight, conserve space, relieve congestion by using only one mounting pad in place of two.

Jack & Heintz starter-generators have been developed from the experience gained in producing more than 190,000 flight-proved d-c generators and starters. The new machines are available in a range up to and including 750-amps d-c and can be readily modified to meet individual requirements of engines up to 4000-lb. thrust (or equivalent hp). The J&H starter-generators are especially designed to operate from a self-sufficient starting source, such as nickel-cadmium or silver-zinc batteries.

Most important: J&H starter-generators do both jobs without compromise of either. Performance and reliability are built in.

Write on your company letterhead for a free copy of our *Starter-Generator Data Book*. Address requests to: Jack & Heintz, Inc., 17635 Broadway, Cleveland 1, Ohio.

JACK & HEINTZ, Inc.

AIRCRAFT SYSTEMS AND EQUIPMENT

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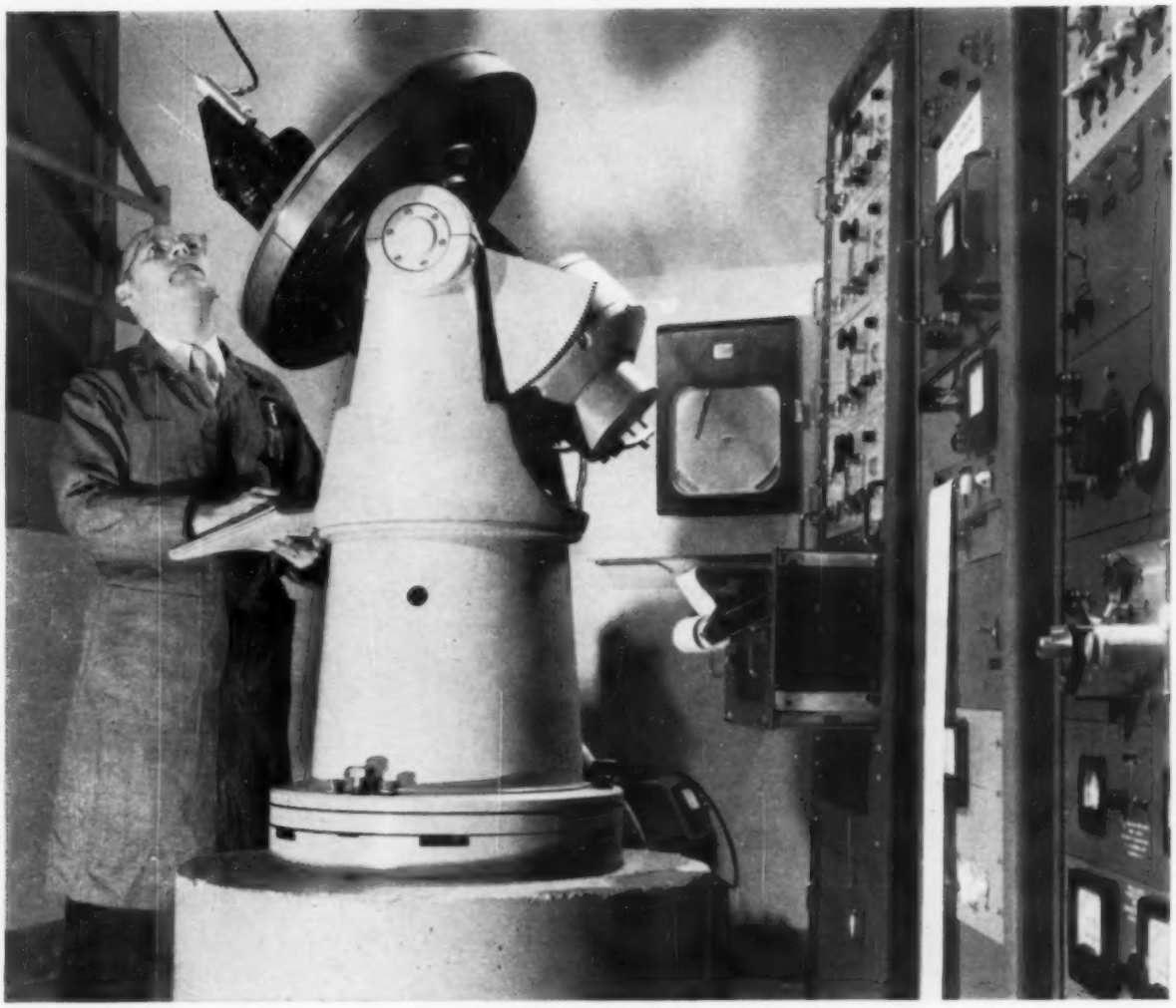

Ford Instrument Co. Engineer checks air-bearing gyro for angular drift on equatorial test stand. Test can show up drift rates as low as one revolution in 40 years. Tests like this . . .

helped Army put "Explorer" into orbit

Some of Ford Instrument's current or recent programs include:

Inertial guidance systems . . . including Redstone and Jupiter

Missile launching and control order computers

Navigational and mission control systems and computers

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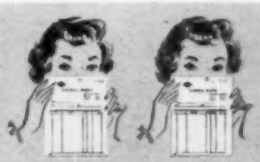

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Defense Contracts Spur 1958 Sales

The aviation industry will hit a level of between $11 and $12 billion in gross revenues for 1958. A sharp and steady upturn in Defense Department contracting for aircraft, missiles and avionic equipment during the next nine months will result in major improvement in the 1958 sales picture with prospects even brighter for 1959.

Industry entered 1958 last January with a backlog of about $17.5 billion in unfilled orders of which a record $3 billion total were for commercial orders. Commercial sales for 1957 also rose to a record $2 billion for more than 18% of the total industry gross revenues.

Industry picture, which darkened considerably during the financial bungling in the Pentagon last summer, will also brighten during the remainder of this year as a result of the Fiscal 1959 Defense Department budget and supplemental appropriations already undergoing congressional approval for the remainder of the Fiscal 1958 budget.

Breakdown of military spending for 1958 indicates the following:

- **$6.9 billion for aircraft, engines, airborne avionic equipment and related procurement.**
- **$3.3 billion for missiles and related equipment, including avionics and ground handling equipment.**
- **$2.2 billion for research and development, the bulk of it devoted to aircraft, missiles, avionic equipment and space technology.**
- **$860 million for ground-based avionic and communications equipment.**
- **$368 million for production facilities.**

COMMERCIAL OUTLOOK

THE COMMERCIAL market will probably total close to $1 billion in transport deliveries with the first significant increment of American-built gas turbine powered transports reaching airline customers during 1958; about $800 million business flying market with about $100 million in aircraft sales plus about $700 million in maintenance, overhaul, fuel and operations costs.

In the key military market that accounted for 82% of the industry's gross revenues for 1957, there will still be some effects felt of the production cutbacks and stretchouts inflicted during the drastic economy wave just before the Soviet Sputniks took to their orbits, and the industry will have to battle valiantly against further strangulation by conflicting and damaging government procurement regulations if it is to boost its net income margin above the pitiful 2.4% of gross sales realized in 1957.

MILITARY SPENDING

As a result of impact of the Soviet's successful testing of an intercontinental ballistic missile over a 4,000 mi. range and the launching of two Earth satellites into successful orbits, the lid has been lifted from military spending in the aerial weapons procurement area and contracting is scheduled to increase 76% during the first six months of 1958 over the last half of 1957. Contracting during the last half of 1958 will be more than 30% higher than the same period in 1957, pushing the total for 1958 new contracting to the highest level since the Korean war.

In addition to taking the brakes off a multi-billion dollar procurement reservoir already appropriated but not obligated by the Pentagon, an additional $1.2 billion now being approved by Congress as a Fiscal 1958 supplemental is expected to be obligated by Defense Department with industry by the end of the 1958 fiscal year on June 30.

As always, the future prospects of the aviation industry and its related technologies will be dominated by major technical changes that also will portend major business shifts. Major research and development effort is now spread over the entire spectrum of manned aircraft (WS-110A chemical fueled Mach 3 bomber and WS-125A nuclear powered aircraft) through ballistic missiles, defensive missiles and space technology. How fast individual firms in the industry develop capabilities in these new fields—in every strata from prime weapon system manager down to supplying the vital but specialized new types of fasteners,

valves and fuel lines—will determine their prosperity in the immediate future.

There probably will be fewer major weapon systems developed and produced, but these systems will be infinitely more complex and expensive than the current generation of weapons in production. They will require much larger combinations of technical and industrial complexes spread over much broader areas of technology to undertake successfully the necessary research and development to bring them to the production phase.

The spectacular pace of this galloping technology is demonstrated by the fact that ballistic missiles, which only a few months ago were being hailed as the "ultimate" weapons, are now clearly just a transitory phase of new weapons development, with much more sophisticated and effective weapons such as air launched missiles, the hypersonic glide bomber, the manned space vehicle and a military outpost on the Moon already in the research and development mill.

SPACE TECHNOLOGY NEED

IT IS CLEAR too that, while ballistic missiles are an extremely transitory phase of the weapons development cycle, the development of space technology to adequately enable man to explore and usefully utilize the vast reaches of outer space will probably be a major occupation of the aviation industry and its related technologies for a half century or more.

In the military market it is clear that manned aircraft will continue to provide the major portion of sales during 1958 with missiles rising to about 30% of the total revenues. However, by the end of 1958, missile orders will probably account for about half the total military order backlog. It is clear that missiles will not replace manned aircraft, even in the current transitory phase before manned space flight, but that missiles and manned vehicles will continue to supplement each other in the airpower arsenal. A good example of how this mixed bag is developing for the future is the new USAF concept of the air-launched 1,500 mi. range missile utilizing either a chemically or nuclear fueled manned vehicle to transport IRBMs to an altitude and range from the target that will enable them to do their job without the tremendous first stage propulsion systems and fixed launching sites now required.

In the development of space technology, the course for the immediate future is already clear—well-planned and logical step-by-step exploration of space using the giant rocket engines developed for ballistic missiles to hurl scientific probes into space; next, the reconnaissance satellite; after that put a man into space and bring him back safely, then the mannned space station and, finally, establishing a manned base on the Moon.

Looking to other phases of the aviation market, the airlines face another difficult year with the paradox of rising traffic and revenues combining with drastically reduced profits. One of the big bottlenecks to future air traffic expansion will not ease during 1958. This is the saturation of the current air traffic control system that restricts maximum volume operations during periods of even moderately bad weather. But this problem now looms secondary to that of filling the vastly expanded airline seat capacity both in domestic and international service. Halting the downward trend of load factors is the most acute of a large collection of airline problems.

The first impact of the jet transport age will be felt in 1958 with not much indication that airlines or the cities to be served have done much to handle the many operational, sales and service problems involved. U. S. flag airlines should gross over $2 billion in 1958 but will retain a smaller portion as net than during 1957.

BUSINESS FLYING OUTLOOK

THE BUSINESS FLYING field is still growing with sales of just over $100 million in new aircraft for 1957 and prospects for a slight increase in this dollar volume for 1958.

In the face of a generally increasing gross revenue all segments of the industry will face the spectre of government policies and regulation that will whittle away the fruits of this effort in net income. The industry must increasingly face the hard facts of these government trends and lose its previous inhibitions in telling its story to the American people who depend on it for adequate defense, swift transportation and a deep sense of national pride.

—Robert Hotz

Genies on Voodoo; Thor and Sergeant

McDonnell F-101B Voodoo (top) carries Douglas MB-1 Genie air-to-air missiles. Douglas Thor IRBM (bottom, left) shown with ground support equipment including transporter-erector used to move and raise missile; launch mount or base; and power-pack trailer with mechanisms for actuating initial steps of firing sequence. Bottom, right, is Army's Sergeant surface-to-surface missile.

Military....

Convair's F-106 Delta Dart

READY NOW—Not a dream of the future, but "hardware" today, the Northrop Snark SM-62 is now being produced in limited quantities for the Strategic Air Command. Air Force ground and technical crews are in training and an accelerated production schedule of this relatively low-cost missile can be our strongest deterrent to enemy aggression. Years in development, the Snark has repeatedly proved its ability to deliver nuclear warheads on targets more than 5,000 miles away at speeds in the sonic band. The Snark is automatically guided to its target by a self-contained guidance system that defies jamming or misdirection by the defender. Enemies of the free world are well aware that the U.S. has this fully developed intercontinental guided missile—capable of flying from concealed mobile launchers to hit a target anywhere in the world. A formidable companion to the long-range bombers of the Strategic Air Command, the Snark is another reflection of Northrop Aircraft's "security with solvency" philosophy of delivering more air power per dollar.

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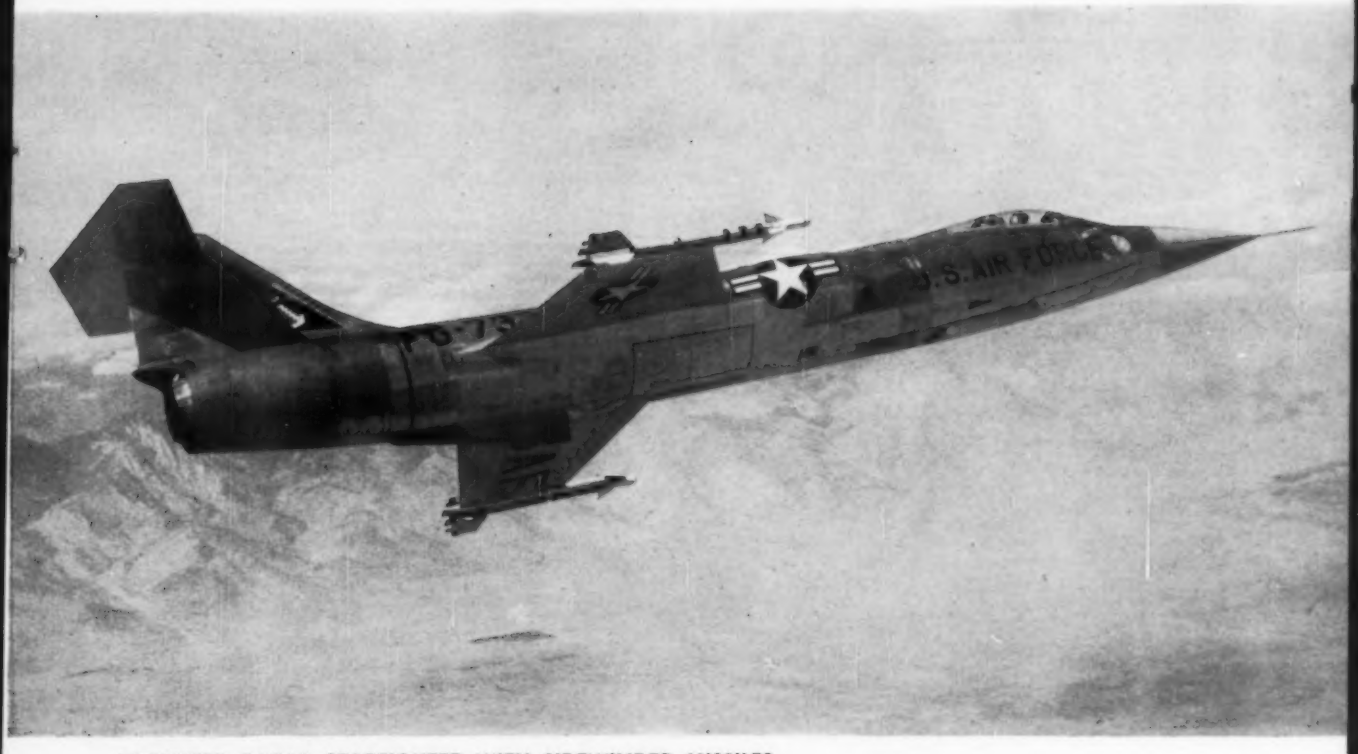


LOCKHEED F-104A STARFIGHTER WITH SIDEWINDER MISSILES

USAF Gears for Space Challenge

By Evert Clark

Critical year in Air Force's transition from aircraft to a mixed inventory will be further complicated by the space challenge, another reversal in basic fiscal policy and increasingly serious financial problems that are plaguing the aircraft industry.

Total procurement in the coming fiscal year will be slightly greater than in Fiscal 1958, and it will be spread more evenly, producing a far healthier financial climate than the drastic stop and go measures that have marked the past 10 months.

Missiles continue to demand an increasing share of USAF's procurement dollar, and total number of aircraft continues to decline.

But Air Force and industry leaders have taken unusual pains in recent months to counteract the growing missile myth by pointing out that:

• **Manned aircraft** will continue to be the backbone of USAF's deterrent force for some years before missiles can be produced in sufficient numbers and made both technically and operationally reliable.

• **Missiles are merely** an evolutionary step, rather than anything approaching an ultimate weapon.

"The missiles that are getting the headlines today are but one step in the evolution from aircraft to piloted spacecraft," according to Gen. Thomas D. White, USAF chief of staff.

Gen. Orval Cook, president of Aircraft Industries Assn., also notes the transistory nature of the missile.

Man and Missile

"Just as we begin to enter the so-called 'missile age,' it suddenly appears that it is only a way station; that the next step is to add a man to a missile," Gen. Cook said.

"Then we give this manned missile another missile to fire at the target, and then we are right back where we started —back to the manned vehicle!

"All we have done is to provide man with a fantastically increased reach—both in space and in time."

USAF expects to spend $4.97 billion for manned aircraft in the next fiscal year, a decrease of 8% from 1958.

Missile expenditures will increase 7% over the 1958 figure, which included $683 million in supplemental funds requested after Sputnik. Fiscal 1959 total is expected to be $2.112 billion and could be higher if Air Force's desire to accelerate ballistic missile programs still further is translated into supplemental budget requests.

New obligations for missiles in Fiscal 1959 will be approximately $2.704 billion—an increase of 43%—reflecting production orders for the larger missiles.

Aircraft orders will total some $3.991 billion, a 5% decrease from the $4.223 of last year. Active aircraft inventory will decrease 1,214 from a planned 22,057 on June 30 of this year to 20,843 on June 30, 1959.

To see how rapidly last year's economy programs and the advent of missiles changed planning, it is necessary to look at the active aircraft inventory predicted for the end of Fiscal 1958 when that budget went to Congress a year ago—24,398 planes. That figure now is expected to be only 22,057, or 2,341 planes less.

This transition to an inventory composed of manned aircraft, missiles and the spacecraft to follow has been accelerated by Soviet satellite and missile successes of the past year and technological gains here at home.

The acceleration follows a period of

BOEING B-52 STRATOFORTRESS FORMATION

extremely harmful and confusing deceleration that missed its real goal of saving money because Sputnik reversed the trend. The slowdown also left deep financial scars on USAF's essential teammate, industry, and had serious effects on the economy as a whole.

One example of the effect of last year's fiscal controls is total employment in the aircraft industry. Last April it reached 906,000, an all time record that was well above the 800,000 average for 1956—the year when aircraft became the nation's largest manufacturing industry for the first full year.

By the end of last November, contract cancellations, stretchouts of existing production programs and abnormal delays in getting new programs under way had cut employment by more than 100,000 jobs.

USAF Planes on Hand

1955	23,694
1956	26,760
1957	25,969
1958	22,057
1959	20,843*

Note: Figures are as of the end of each fiscal year for 1955-1959. Figures for previous years are as of Jan. 1.

* Includes 19,142 operating aircraft and 1,701 nonoperating active aircraft.

Defense industries have become a vital part of the total economy. Aircraft and missile development and manufacture comprises the major part of defense effort.

Maj. Gen. Bernard A. Schriever, chief of USAF's ballistic Missile Division, has called attention to the fact that the ballistic missile program is truly a national effort.

Pivotal Trend

"The Air Force ballistic missile program is a symbol of a pivotal trend in our society that is too little recognized," Gen Schriever said. "It is simply this—the military establishment and pursuits can no longer be regarded as things entirely apart from civilian establishments and pursuits.

"The military and civilian segments of our national life do not exist in two compartments, hermetically sealed against each other.

"Today, as never before, our military and civilian aims and actions are inseparable. Our effort is a joint effort because our problem, the survival of freedom, is a joint problem.

"The challenge is total. Our response must therefore be total. In the future we must draw upon our human and material resources in the armed forces, in industry, in education, in civilian branches of the government, and from every other group in our country.

"The Air Force ballistic missile program is a symbol of the total effort required from all of us if freedom is to flourish. . . . The national character of the program is illustrated by the fact that participating in the program are 22 industries, 17 prime contractors, 200 sub-contractors, 4,000 suppliers and about 83,000 people who are directly involved."

Force Levels

The following military airpower force levels are scheduled to be reached by the end of Fiscal 1959:

USAF—105 wings

NAVY—16 carrier air groups
20 carrier anti-submarine squadrons
3 Marine air wings

ARMY—5,439 aircraft

U. S. Plane Inventory

(End of fiscal year)

	1958	1959
USAF	22,057	20,843
NAVY	10,654	9,826
ARMY	4,937	5,439
TOTAL	37,648	36,108

● USAF

Highlights of USAF's past year have included first test firings of the Convair Atlas intercontinental missile and the Douglas Thor intermediate range missile; transfer of responsibility for initial operational capability from Schriever's branch of Air Research and Development Command to Strategic Air Command and activation of units which will fire the Atlas, Titan, Thor and Jupiter; beginning of activation of ballistic launching bases at Cooke AFB, Calif., and Warren AFB, Wyo., and formation of the 556th Intercontinental Guided Missile Squadron to fire the Northrop air-breathing Snark missile.

Boeing Bomarc interceptor missiles were put into production and the Douglas Genie, an atomic air-to-air rocket for interceptors, went into the operational inventory. Bell Rascal air-to-ground missile and improved Martin Matador surface-to-surface missiles also went into use.

USAF also disclosed development on the North American WS-131B Hound Dog, a ground-to-air missile for use with B-52's; the McDonnell Green Quail and Fairchild Bull Goose diversionary missiles; and talked of improved long-range pods for the B-58 bomber and air-launching of future missiles of the force and range of an intermediate ballistic missile, possibly from nuclear aircraft or the North American WS-110A

Major USAF Commands

North American Air Defense Command* Ent AFB, Colorado

Air Materiel Command Wright Patterson AFB, Ohio

Air University Maxwell AFB, Alabama

Air Training Command Randolph AFB, Texas

Air Research & Development Command Andrews AFB, Maryland

Headquarters Command Bolling AFB, Washington, D. C.

Continental Air Command Mitchel AFB, New York

Strategic Air Command Offutt AFB, Nebraska

Tactical Air Command Langley AFB, Virginia

Air Defense Command Ent AFB, Colorado

Military Air Transport Service Scott AFB, Illinois

Alaskan Air Command Elmendorf AFB

Caribbean Air Command Albrook AFB, C.Z.

Pacific Air Force Hickman AFB, Honolulu

USAF Europe Wiesbaden, Germany

USAF Security Service Kelly AFB, Texas

Air Force Finance Division Denver, Colorado

Air Force Academy Lowry AFB, Colorado

* Joint U.S.-Canadian command; formerly Continental Air Defense Command.

USAF Aircraft on Order

Acft. Type	Popular Name	Manufacturer
BOMBERS		
B-52E, F, G	Stratofortress	Boeing
B-58A	Hustler	Convair
FIGHTERS		
F-100D, F	Super Sabre	North American
F-101A, B, C	Voodoo	McDonnell
RF-101C	Voodoo	McDonnell
F-102A	Delta Dagger	Convair
TF-102A	Delta Dagger	Convair
F-104A, B	Starfighter	Lockheed
F-104C, D	Starfighter	Lockheed
F-105B, D	Thunderchief	Republic
F-105E	Thunderchief	Republic
JF-105B	Thunderchief	Republic
F-106A	Delta Dart	Convair
F-106B	Delta Dart	Convair
TRANSPORTS		
C-130A, B	Hercules	Lockheed
RC-130A	Hercules	Lockheed
C-133A	None	Douglas
KC-135A	Stratotanker	Boeing
C-123B	Provider	Fairchild
TRAINERS		
T-33A	Shooting Star	Lockheed
T-37A	None	Cessna
T-38A	None	Northrop
HELICOPTERS		
H-43A, B	None	Kaman
LIAISON		
L-27A	None	Cessna

chemical bomber now under development.

Work toward an atomic rocket engine at North American Aviation, Inc., was disclosed, and studies on nuclear ram-jets continued under Atomic Energy Commission. Further discussion of missile programs can be found on p. 91.

Industry's Problems

Contracting and financial problems continue to harass both Air Force and industry. Assistant Secretary for Materiel Dudley C. Sharp said USAF lets about a million contracts each year, and "contracting is one of our biggest headaches."

Gen. Cook pointed out that companies comprising AIA receive at least 85% of the total dollars spent on aerial vehicles. Much of this money is passed along to suppliers and subcontractors, but Gen. Cook listed some of the problems that this responsibility has forced on the aircraft industry:

• "**To survive in this highly** competitive business and in the face of fantastically rapid technological change, we have reinvested our earnings at the highest rate —approximately 60%—of any manufacturing industry.

• "**In the ballistic missile** program alone, the aircraft industry has invested —that is to say, risked—more than $100 million for industrial facilities.

• "**The aircraft industry** in the years since World War II has spent $1 billion on research and test facilities and plans to spend another $1 billion in the next five years. Obviously, this industry cannot continue to maintain such a pace if earnings continue the decline experienced in 1956 and 1957.

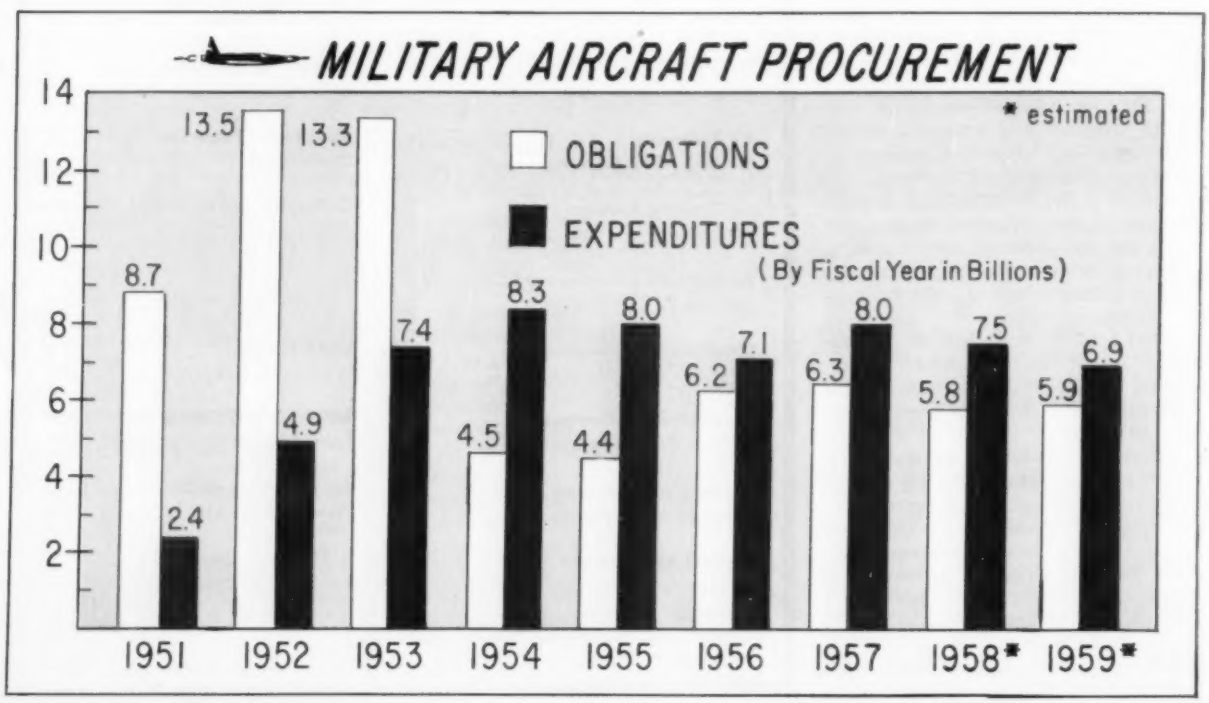
• "**Another severe and continuing** drain on our financial resources is the replacement cost of worn-out tools. . . . Just to replace one $22,000 machine, we must sell $780,000 worth of product! Therefore it is sales which produce the earnings; not capital or net worth.

• "**Recent Defense Department** directives reducing progress payments (even though the work has already been performed) for both fixed price and cost-plus-fixed-fee contracts, have forced industry to finance a much larger share of its work and have placed a severe drain on its financial resources.

• "**Earnings rate of our industry** already is well below the average for all industry. Our requirements for capital are at an all time high. The government is demanding that we finance more of our work in process and provide more of our basic facilities.

• "**Added to all this,** the decisions of the Renegotiation Board in endeavoring to recapture what it calls 'excess profits' earned three or four years ago, are little short of catastrophic. We thoroughly agree that the government should recapture truly excess profits. Adequate laws to accomplish this, such as the Vinson-Trammel Act, already exist, but the Renegotiation Act, as presently administered, stifles incentive and encourages inefficiency."

Gen. Cook also lists "limitations on the allowance of research and develop-



B-58 HUSTLER WITH CONVAIR CHECK CREWS

ment costs" and "policies and practices transgressing contractors' proprietary rights" among industry's grievances.

Cook said this outspoken attitude is a departure from AIA's policy of avoiding "public statements and expressions on military matters, national policies and the adequacy, size and composition of our defense forces.

"From time to time, however, it is important that we speak up, so that our role and obligations may be understood. And with that understanding, assess our capabilities more accurately."

Manned Aircraft

On its side, USAF also has great problems of maintaining a manned aircraft force to match the threat of more than 21,000 Russian combat aircraft and a large stockpile of Russian intermediate missiles.

To that continuing challenge are being added the new challenges of Soviet efforts in intercontinental range missiles and space.

These new threats have caused more outspokenness among USAF leaders, just as they have with industry.

Space has been brought out from under the table. USAF's timidity on the subject—not all of it forced by official Defense Department attitudes—has disappeared, and USAF now openly claims control of space as its logical military mission.

While post-Sputnik reassessments and resulting reorganizations already are affecting USAF's role, there is little doubt that the foundation laid by men such as Yeager, Everest, Apt, Kincheloe, Stapp, Simons and others have put Air Force very squarely into the space picture.

"We airmen who have fought to assure that the United States has the capability to control the air are determined that the U.S. must win the capability to control space," Gen. White said recently.

"In speaking of the control of air and the control of space, I want to stress that there is no division, per se, between air and space. Air and space both are an indivisible field of operations.

"Ninety-nine per cent of the Earth's atmosphere lies within 20 mi. of the surface of the Earth. It is quite obvious that we cannot control the air up to 20 mi. above the Earth's surface and relinquish control of space above that altitude—and still survive."

Brig. Gen. Homer A. Boushey, USAF's deputy director for research and development, even foresees the probability that the Moon will become an operational military base from which some nation will control all of Earth.

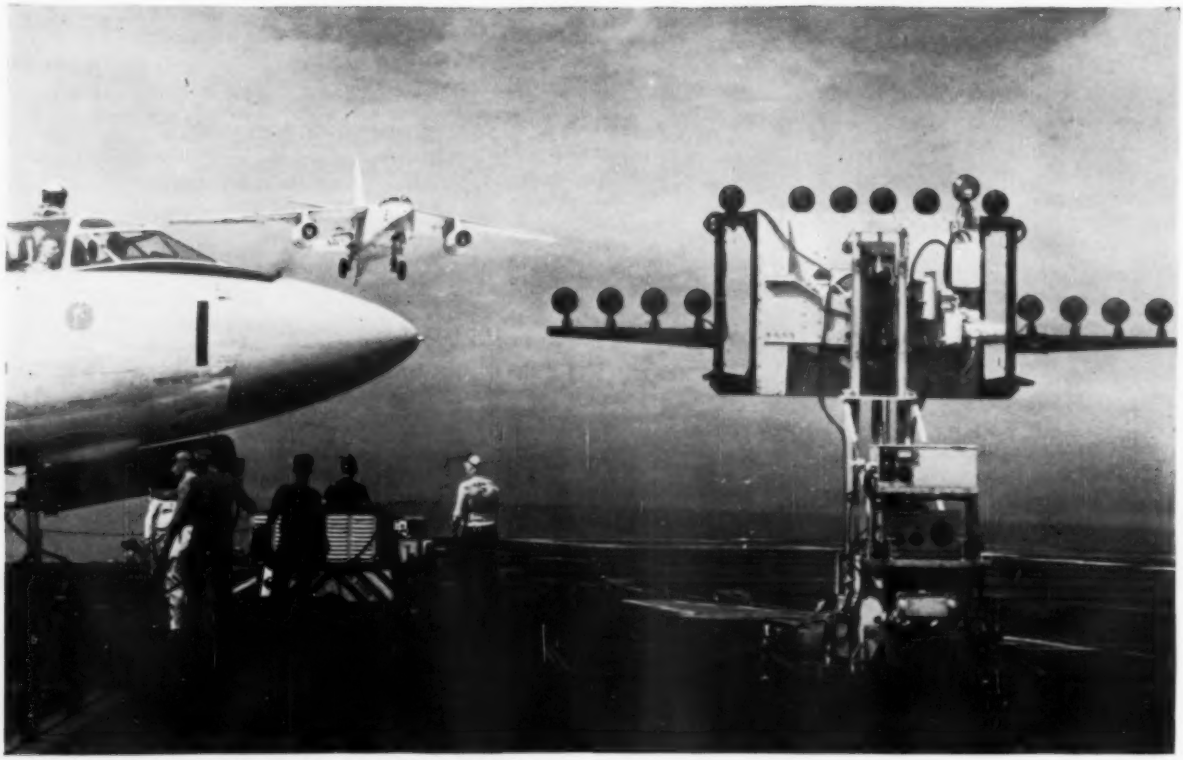
Gen. Boushey for one day headed USAF's Directorate of Astronautics before Defense Department ordered the Air Force to withhold its action until other organizational problems were worked out—an exercise which Boushey describes as "the quickest escape and quickest re-entry on record."

Space Control

In spite of this reversal, Defense officials apparently are prepared to agree that USAF is the logical explorer of space in one of mankind's greatest challenges.

Defense Secretary Neil H. McElroy told a press conference recently that service responsibility for manned satellites had not yet been decided, "but I would think that that might very probably remain with the Air Force as a project inasmuch as manned flight has been their responsibility.

"That can be determined later, but that would be my expectation, that that would naturally remain with the Air Force as a responsibility."



DOUGLAS A3D-2 SKYWARRIOR CARRIER LANDING

Navy Eyes Space, Plans Versatile Fleet

By Cecil Brownlow

Navy is retooling for the future with an eye toward space and a firm conviction that seapower and the aircraft carrier are far from approaching obsolescence.

Navy's overall planning, conducted quietly and with a minimum of inter-service wrangling, is designed to provide a fleet that can be effective over the entire spectrum of possible conflict with the Soviet Union—from crises where a simple show of force may be sufficient; to limited, non-nuclear wars, and on to an all-out nuclear war. It sees a need and place for manned aircraft and aircraft carriers in all phases of the spectrum.

One indication of Navy's move to add versatility to its fleet air arm came early this year when the Bureau of Aeronautics awarded a contract to Grumman Aircraft Corp. for a two-place jet attack aircraft. Airplane is to be designed for both high and low-altitude operations (AW Jan. 6, p. 34).

Designation of the carrier-based jet aircraft is the A2F.

Lear already has developed the AJB-3 LABS bombing system for the Navy (AW July 22, p. 63).

In another field, the Bureau of Aeronautics is searching for a long-range air-to-air guided missile that could radically effect future Navy fighter designs.

The Navy also sees a need to go to space, and—with the bitter USAF-Army battle over the intermediate range ballistic missile in mind—emphasizes that such programs should be conducted on a tri-service basis. Adm. Arleigh A. Burke, chief of naval operations, recently told the House Armed Services Committee that what Navy wants most from space are satellites for reconnaissance, communications relay and all-weather navigation aids.

The need for such navigation aids will become even greater with the advent of the Polaris fleet ballistic missile system now scheduled to become operational in October, 1960.

Navy Planes on Hand

(End of Fiscal Year)

1956	12,317
1957	11,617
1958	10,654**
1959	8,360**

**Planned

Polaris Acceleration

Taking advantage of across-the-board developments and the relaxed purse-strings that followed successful Soviet launchings of two Earth satellites last fall, Navy has managed to shave three years from its Polaris timetable, and Navy Secretary Thomas S. Gates, Jr., says it can be trimmed still more if additional funds are provided.

With $350 million from the Administration's supplemental budget request for Fiscal 1958, Navy last month let contracts for the first three Polaris submarines.

Two of these are to be built by the Electric Boat Division of General Dynamics Corp., the third by the Navy-owned shipyard at Mare Island, Vallejo, Calif. Each submarine will carry 16 Polaris missiles.

Secretary Gates says another six Polaris submarines can be built within the same time span if the Defense Department and Congress approve a re-

CHANCE VOUGHT F8U-1P CRUSADER

quest for an additional $1 billion.

In weapon systems as a whole, Rear Adm. F. S. Withington, chief of Navy's Bureau of Ordnance, sees these trends:

• **Move toward weapon** system development will continue and there will be fewer developments.

• **Bureau of Ordnance will** continue to decentralize the direction of development projects to various laboratories, such as the Naval Ordnance Laboratory, Naval Ordnance Test Station and Johns Hopkins' Applied Physics Laboratory.

• **Integration and coordination** of development effort in cases where more than one bureau is involved will be improved under the newly established "lead bureau" system.

• **Navy will play** an important role in satellite and related developments.

• **Submarine detection** equipment and mine mechanisms that are more sensitive and resistant to countermeasures must be developed.

R&D Emphasis

In its research and development effort, Navy is putting major emphasis upon these areas:

• **Electronics,** with a major effort toward better long-range detection from both sea and air.

• **High temperature metallurgy.**

• **Higher speeds and altitudes** for missiles and aircraft, although high-altitude aircraft may soon come under competition from "slow planes."

Overall, Adm. Burke says the nuclear-powered Navy of the future will have more submarines, about the same number of surface ships and somewhat less aircraft than Navy is planning for the end of Fiscal 1959.

The primary "kill" weapon will be the missile, for both defense and offense, and Navy has shepherded together a formidable group. In addition to the Polaris underwater-to-surface missile, whose use is primarily restricted to all-out war because of its nuclear warhead and its design to hit "soft" rather than "hard" targets, the Navy has—or will have—the following missiles in its inventory:

• **Air-to-surface.** Most advanced design nearing production is the Corvus.

Prime contractor for the missile, designed to keep aircraft away from heavily-defended target areas and similar to the USAF's Rascal, is Temco Aircraft Corp.

In the short-range field, Navy has the Martin Bullpup scheduled to become operational late this year. Designed for light attack aircraft on close-support missions, Bullpup weighs 540 lb. and has a length of 11 ft.

• **Air-to-underwater.** Navy has announced two operational anti-submarine

Navy Aircraft on Order—1958

COMPANY	PLANE	NAME
	FIGHTERS	
Chance Vought	F8U-1	Crusader
Douglas	F4D-1	Skyray
	F5D-1	Skylancer
Grumman	F9F-8	Cougar
	F11F-1	Tiger
	F9F-8P	
McDonnell	F3H-2, -2M, -2N	Demon
	F4H-1	(No Name)
North American	FJ-4	Fury
	ATTACK	
Douglas	AD-7	Skyraider
	A3D-2	Skywarrior
	A4D-1, -2, -3, -2N	Skyhawk
Grumman	A2F	
North American	A3J-1	(No Name)
	PATROL	
Grumman	S2F-1	Tracker
	WF-2	(No Name)
	W2F	
Lockheed	P2V-7	Neptune
	WV-2	Constellation
	W2V-1	
Martin	P5M-2	Marlin
	YP6M-1	SeaMaster
	P6M-2	SeaMaster

COMPANY	PLANE	NAME
	TRANSPORTS	
Convair	R4Y-2	Tradewind
Grumman	TF-1	Trader
	TRAINERS	
Lockheed	T2V-1	SeaStar
North American	T-28C	Trojan
	T2J-1	(No Name)
Temco	TT-1	Pinto
	HELICOPTERS	
Bell	HTL-7	
Gyrodyne	HRDN-1	
Hiller	HRDE-1	
Kaman	HUK-1	
	HU2K-1	
Sikorsky	HSS-1, -2	
	HUS-1	
	HRS-3	
	HR2S-1	
	BLIMPS	
Goodyear	ZPG-2W, -3W	
	ZS2G-1	

GRUMMAN F11F-1F SUPER TIGER

missiles in this field, the Betty and the more sophisticated Lulu. Both are equipped with nuclear warheads. An earlier missile, the Fairchild Petrel, has been retired from active duty and is now used by reserve units only.

• **Underwater-to-air-to-underwater.** This anti-submarine warfare missile reportedly is still in the development phase. When fired from a submarine, the missile would surface, leave the water to fly its trajectory and then re-enter to home on its target. Aerial trajectory would give the missile greater range and speed.

• **Air-to-air.** Navy now has four squadrons equipped with Sparrow I, a supersonic beam-rider built by Sperry Rand. Sparrow I will begin to phase out late this year with the fleet introduction of Raytheon's Sparrow III, a fully-active homing missile now undergoing operational development. Sparrow III will be used initially on the McDonnell F3H-2M.

Sidewinder, a Mach 2-plus infrared homer, that also is being produced for Air Force, is now the primary armament for 32 Navy and Marine squadrons and more are planned. At present, 15 carriers have been modified to support Sidewinder squadrons. Produced by Philco and General Electric, its cost is $4,000 each as compared with $40,000 for other comparable weapons. However, since it is a heat homer, it is not useful in cloud formations.

• **Surface-to-surface.** Single operational missile at present is the subsonic Regulus I. Now carried by two submarines and aboard several carriers, it has a range of about 500 mi. and will be supplanted next year by Regulus II. Both missiles are products of Chance Vought. Regulus II, with a Mach 2 speed and a 1,000 mi. range, can be fitted with either conventional or atomic warheads. It is inertially guided and powered by a General Electric J79 turbojet engine.

First Regulus II submarine will be ready in 1960, but the missile will go aboard cruisers and carriers next year.

• **Surface-to-air.** The three weapons in or nearing inventory in this category are Convair's Terrier and Tartar and the Bendix Talos.

Terrier Operational

Terrier, already operational aboard the guided-missile cruisers Boston and Canberra and the destroyer Gyatt, weighs approximately 1.5 tons and has a range of over 10 mi. It also will be used aboard the carriers Kitty Hawk and Constellation; the cruisers Topeka, Providence and Springfield; the nuclear cruiser Long Beach, and the frigates Farragut, Luce, McDonough, Coontz, King, Mahan and Dewey. In addition, one Marine anti-aircraft battalion is equipped with Terriers.

A follow-on to the Terrier is the ramjet-powered Talos, which has a range of over 40 mi. and can carry an atomic warhead. The Talos will go to sea this fall aboard the cruiser Galveston. It also will be the primary weapon aboard the nuclear cruiser, Long Beach, scheduled for commissioning in 1960. In addition, the cruisers Oklahoma City and Little Rock are being converted to its use.

Tartar is designed especially for use aboard destroyers and will become operational in 1960. It has approximately the same range as Terrier although it is much smaller.

'Buddy' Refueling

Navy also will extend its effective striking range this year with the introduction to the fleet of the "buddy" refueling system. The "buddy" system, in which one plane of a type is equipped as a tanker to refuel another aircraft of the same type, will be used by Douglas ADs and A4Ds and the McDonnell F3H series.

The Douglas A3D attack bomber will be used as a tanker for both "buddy" and fighter refueling.

Prime contractors for the "buddy" system hardware, including pods and droppable tanks, are Douglas and McDonnell.

Also, Bureau of Aeronautics' careful selection of aircraft projects will pay new dividends in aircraft again this year. New aircraft planned include:

• **Chance Vought F8U-2.** First production aircraft of this advanced version of the F8U-1 is due off the production line later this year. First two prototypes of the aircraft, which will be produced in quantity, already have flown—the first in December, the second in January. Main armament will include Sidewinder. Improvements over the F8U-1 include an advanced version of the Pratt & Whitney J57 engine.

• **Chance Vought F8U-3.** First flight

DOUGLAS A4D-1 SKYHAWK

of this bigger, all-weather version of the F8U series is scheduled for this summer. Although it bears an external resemblance to earlier F8U models, it is essentially a new aircraft with a design speed of Mach 2 plus. Powerplants will be a Pratt & Whitney J75 engine rated at 15,000 lb. thrust and a rocket motor. Navy has announced a $100 million order for the aircraft.

• **McDonnell F4H.** Considered in some quarters to be a dead project after Navy placed its order for the F8U-3, the F4H is still very much alive. Prototype of the twin-engine, all-weather fighter-attack bomber is scheduled to fly next month. Designed for Mach 2 speeds, the F4H is powered by General Electric J79s rated at 12,000 lb. thrust each.

• **North American A3J.** First model of this twin-jet "high-supersonic" attack aircraft will fly late this year. The two-place, carrier-based aircraft is powered by General Electric J79s and was the first Navy plane to be designated a weapon system.

It is being produced by North American's Columbus Division.

• **Martin P6M-2 jet seaplane.** Navy officials feel the major "bugs" which caused the first two XP6Ms to crash have been corrected in the YP6M which began flight tests in January. If evaluation trials prove successful, the P6M-2 will be introduced to the fleet in 1960. At present, Navy has an order for 24 of the four-jet seaplanes, which will be used primarily for mine laying, photo reconnaissance and early warning missions.

Powerplants are Pratt & Whitney J75s.

• **Douglas A3D-2P.** A photo reconnaissance version of the A3D attack plane, the A3D-2P is in production at Douglas' El Segundo Division. An A3D-2T trainer version also is in production at El Segundo, and an A3D-2Q countermeasurers version is planned.

• **Grumman S2F-3.** An improved version of the S2F carrier-based submarine hunter-killer, it will begin flight tests in early 1959.

Versatile Trainer

• **North American T2J.** First model of this two-place jet trainer was rolled out at North American's Columbus Division early this year. Designed to take students from primary through advanced training, including carrier indoctrination, the T2J has a top speed of 429 kt. and is powered by a Westinghouse J34-WE-46 producing 3,400 lb. thrust (AW May 13, p. 52). Navy says it plans a "substantial" order.

• **Temco TT-1.** Evaluation tests of this primary jet trainer, for which Navy has an order for 14, will begin this year. Powerplant is the Continental J69.

Navy also hopes to get the go-ahead for construction of a nuclear aircraft testbed, probably incorporating Pratt & Whitney's nuclear engine with the airframe of Saunders-Roe's 10-engine Princess seaplane.

In one of the rare instances where it has failed to keep its skirts clear of such charges, the Navy has come under Capitol Hill criticism for trying to push its way into a development field in which the Air Force already has a head start.

Navy officials contend, however, that its approach would be basically different from that of the Air Force.

USAF wants a high-altitude Mach 3 bomber, while the Navy envisions a slow, low-altitude aircraft for anti-submarine, early-warning and logistics purposes.

Endurance and high-lift capacity would be the major goals.

Bureau of Aeronautics officials say they could bring such a plane along relatively fast if the project were to receive Defense Department and congressional approval.

The Fiscal 1959 budget requests contain money for further feasibility studies by Navy but make no provision for the purchase of hardware.

Budget Pinch

Navy says it is feeling the budgetary pinch in other areas, too. Despite the Administration's post-Sputnik decision to relax its hold-the-line policy on defense spending, Navy Secretary Gates says his service needs at least $12 billion in Fiscal 1959 to hold the line. Its present Administration-approved requests are for $11.1 billion, including the $350 million supplemental fund. Originally—before Sputnik and the advent of Defense Secretary Neil McElroy—Navy had been told by former Defense Secretary Charles E. Wilson to hold its Fiscal 1959 requests to $10.5 billion.

As it stands, Navy will have to trim its manpower from a present figure of 645,000 to 630,000 by the end of Fiscal 1959; its combat effective aircraft from approximately 9,000 to 8,360. Adm. Burke terms the latter figure the "minimum" with which Navy can do its assigned job.

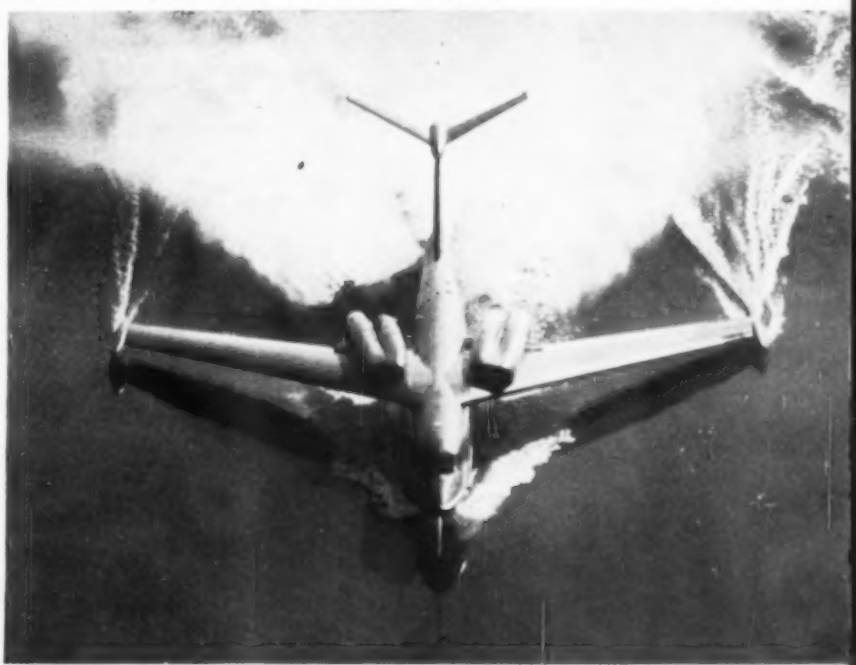
Second Nuclear Carrier

Navy also has been forced to abandon plans to ask for the funding of a second nuclear carrier, although $35 million is being asked in the budget for long lead-time components. Keel for the first nuclear aircraft carrier was laid last month.

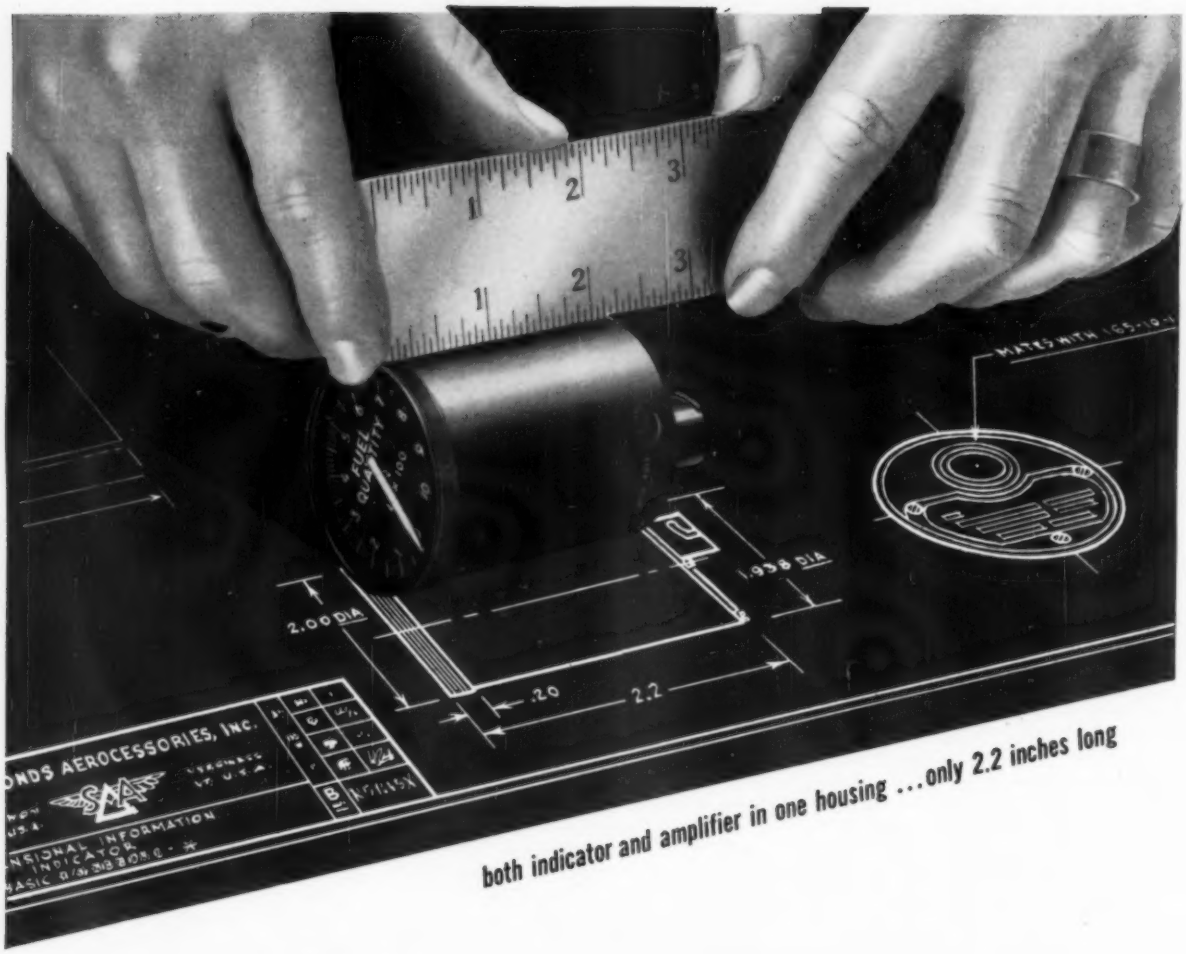
Cost of a nuclear carrier is approximately $315 million as compared with $200 million for a carrier of the Forrestal class, and money originally scheduled to go into the second ship is being diverted to help meet the pressing need for an improved anti-submarine warfare system.

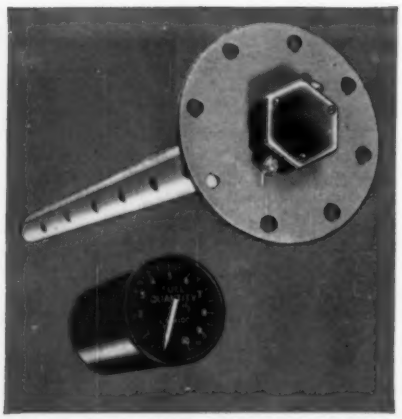
The necessity for an effective submarine defense will become more acute within the near future.

The Soviet Union, which already has approximately 500 submarines, recently slowed its production and apparently is retooling and training its technicians to begin the manufacture of long-range, deep-diving nuclear submarines. Its present fleet has an estimated four submarines equipped with missiles roughly comparable to the subsonic Regulus I.



MARTIN YP6M-1 SEAMASTER





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GRUMMAN AO-1 MOHAWK

Army Fits Aviation Into Tighter Mold

Army Aviation, forced to mold itself to conform with Defense Department weight limitations and a tight fiscal policy, will slowly begin to introduce equipment this year especially designed to fit its needs.

It will break into the turbine age with the appearance of Bell's HU-1A helicopter—production version of the XH-40—and has awarded contracts for such projects as the long-wished-for higher performance observation aircraft, a high-lift STOL cargo plane, aerial jeeps and convertiplanes. In addition, it hopes to begin a design competition within the next three months for a medium size helicoptor capable of carrying a three-ton payload.

One of the primary requirements in all of these is economical operation and maintenance, factors which have taken a heavy toll of Army Aviation funds in the past.

Army has been thwarted in its attempts to bring along the flying crane. The project is now at a standstill, largely because of the lack of funds to finance it.

Army also feels tied down by the Defense Department regulation stipulating that fixed-wing aircraft, convertiplanes and VTOL and STOL aircraft "will have an empty weight not to exceed 5,000 lb."

Thus far, it has received waivers to exceed the limit on two future aircraft, but one top Army Aviation official recently complained that it's hard to get someone in industry to take on a project when he doesn't know whether we can get an exception or not.

The waivers were granted to permit development of Grumman's AO-1 turbine-powered higher performance observation aircraft and the de Havilland AC-1 Caribou twin-engine cargo plane. Army has development contracts for five of each aircraft.

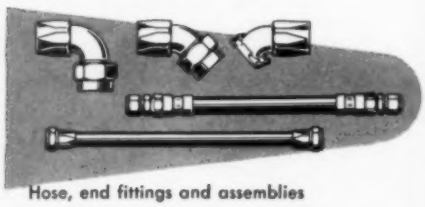
The Mohawk, powered by two Lycoming T53 engines rated at 825 shp. each, is designed for battlefield surveillance and will be equipped with infrared and side-looking radar. For the dash back to friendly lines, the aircraft will have a top speed of 275 kt. It can be slowed to a "loitering speed" of approximately 75 kt. for close surveillance of the battlefield. Mockup already has been completed, and first flight is expected within the next 15 months.

The de Havilland Caribou will give the Army the fixed-wing lift capacity it believes it needs for combat logistics support.

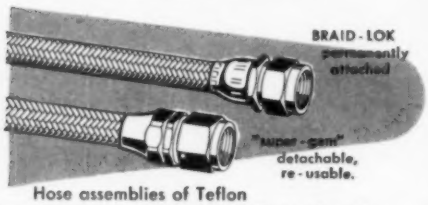
Powered by two Pratt & Whitney 1,450 hp. R2000 reciprocating engines, the Caribou is a follow-on project to the de Havilland U-1A Otter and will be capable of carrying between three

SIKORSKY H-37A MOJAVE

MS (ER) flareless tube fittings

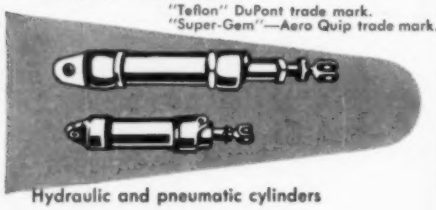


Hose, end fittings and assemblies

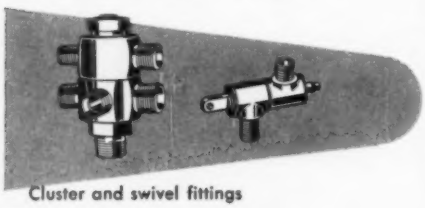


Hose assemblies of Teflon

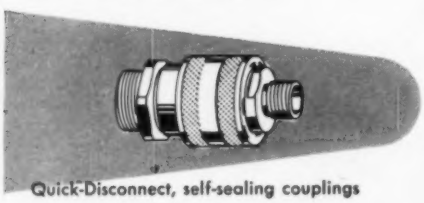
"Teflon" DuPont trade mark.
"Super-Gem"—Aero Quip trade mark.



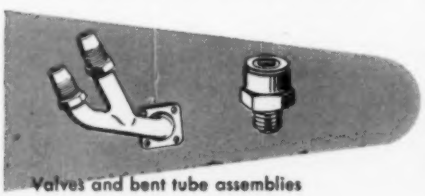
Hydraulic and pneumatic cylinders



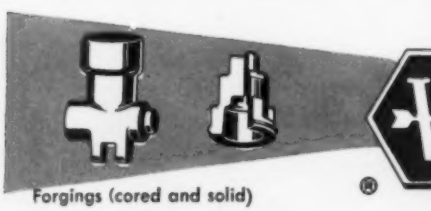
Cluster and swivel fittings



Quick-Disconnect, self-sealing couplings



Valves and bent tube assemblies



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and four tons of cargo as opposed to the Otter's 2,500 lb.

Army also plans to equip one Caribou testbed with Lycoming T55 turbine engines rated at 1,800 shp.

Both the Mohawk and Caribou have the design performance to takeoff within 700 ft. and clear a 50-ft. obstacle.

Surveillance Drones

The observation mission of the Mohawk probably will be supplemented by at least two surveillance drones: the Fairchild Osprey and a relatively-low-speed project under development for Army by Republic Aviation Corp.

Like the Mohawk, the two drones will be equipped with infrared and side-looking radar. Army Aviation has more-or-less abandoned proposals for the use of television for front-line surveillance under the theory that what the television camera can see, man can see.

In the overall picture, Army is turning more and more to helicopters. In Fiscal 1958 planning, for example, 327 helicopters are scheduled to be ordered as compared with 176 fixed-wing aircraft, and by July 1 approximately 43% of Army's aircraft will be rotary-wing vehicles.

Latest of these is the HU-1A, ordered into production last month at Bell Helicopter Corp. in Ft. Worth.

Army's first turbine aircraft, the HU-1A, also is the first helicopter designed throughout with an eye towards meeting the service's demand for simple front-line maintenance.

Powered by a Lycoming T53, the utility helicopter will be used primarily for medical evacuation, carrying two litter cases plus a medical attendant or four walking wounded.

Test versions of the HU-1A are now being flown by Army Aviation Board pilots at Ft. Rucker, Ala.

The giant Sikorsky H-37 twin-engine all-metal helicopter, incorporating a five-blade main rotor and four-blade tail rotor, is completing service tests at Ft. Rucker, and the first company is scheduled to become operational by July 1—joining 10 transport helicopter companies of Sikorsky H-34s and 10 of Vertol H-21s.

The H-37, scheduled to become Army's standard medium transport, will carry 36 fully-equipped troops or equipment up to and including a 105 mm. howitzer plus a quarter-ton trailer.

Army Planes on Hand

(End of Fiscal Year)

1954	3,633
1955	3,539
1956	3,534
1957	4,200
1958	4,937
1959	5,439

RADIOPLANE RP-77D DRONE

YH-31 Canceled

One helicopter development, the Doman YH-31, was canceled during the past year. Army Aviation officials say the utility helicopter offered some advantages over the earlier Sikorsky H-19 but, because of its long development time, these were not enough to warrant a production order—particularly in view of the HU-1A progress.

Looking to the future, Army is conducting a comprehensive research and development program to determine its needs in the fields of VTOLs, STOLs and convertiplanes.

Some officials feel that the convertiplane may eventually take the place of both fixed-wing aircraft and helicopters in Army Aviation but that the time when this can be accomplished is "a long way off."

Development contracts for convertiplanes have been let with Ryan, Vertol and Fairchild.

In addition, Doak Aircraft Co. has received a research contract for five of its X-16 VTOLs incorporating wing-tip-mounted ducted fans that can be tilted 90 deg. after vertical takeoff for transition to horizontal flight. The ducted propellers are powered by a single T53.

'Aerial Jeep' Push

Another major research push is in the field of "aerial jeeps," flying platforms designed to carry a 1,000 lb. payload plus radio equipment and armament. Feasibility of the "jeeps" was proved out by the one-man Hiller Flying Platform and the DeLackner Aerocycle. Piasecki, Chrysler and Aerophysics Development Corp., of Santa Barbara, Calif., a subsidiary of Curtiss-Wright Corp., have research contracts for the "aerial jeep."

All three programs are on schedule, and Army hopes to have at least one model flying within the next year. Much of the wind tunnel work on the project has been conducted for Army by the National Advisory Committee for Aeronautics.

Basic responsibility for Army's aeronautical research and development work lies with the Transportation Research and Engineering Command (TRECOM) at Ft. Eustis, Va. Former name of the recently-renamed command was the Transportation Research and Development Command (TRADCOM).

Army Types on Order

Army currently is purchasing the following fixed- and rotary-wing aircraft

Company	Designation	Type
Cessna	L-19	Observation
De Havilland	L-20	Utility
Beech	L-23	Command
Aero Commander	L-26	Command
De Havilland	U-1	Cargo
Bell	H-13	Reconnaissance
Sikorsky	H-19	Utility
Piasecki	H-21	Cargo
Hiller	H-23	Reconnaissance
Sikorsky	H-34	Cargo
Sikorsky	H-37	Cargo
Bell	UH-1	Utility

Note: Now under development is a Higher Performance Observation Aircraft, the Grumman AO-1. Also, procurement of a service test quantity of the YC-1BH de Havilland Caribou, is planned. Both of these planes will exceed the 5,000 lb. weight limitation on Army aircraft but exceptions have been granted by the Defense Department.

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NATO Missile Use Hinged to Summit

Paris—East-West relations during 1958 should determine whether NATO shifts from its present defense role with main dependency on tactical weapons over into a new strategic role where NATO forces would be armed with IRBM weapons capacle of destroying targets well within the Soviet Union. Such a shift in NATO's traditional role is indicated by decisions taken during the December NATO summit meeting. At U. S. suggestion, European NATO members accepted "in principle" the idea of IRBM bases within NATO territory along with the establishment of an atomic stockpile out of which nuclear warheads would be drawn for IRBM and other weapons deployed among NATO forces.

But before certain reluctant European NATO members accept IRBM bases on their national territory it will be necessary for the West to meet the Russians at summit level in one last attempt at thawing out the cold war. The European desire to talk once more with the Russians before committing themselves to IRBM weapons was openly expressed at the NATO December meeting, and was written into the final communique.

IRBM Plans

Meantime, Gen. Lauris Norstad, supreme allied commander for Europe, is under orders to move ahead with plans for the installation of the IRBM bases within his command. According to the directive handed him by the NATO Council in December, he must turn over his IRBM recommendations this month to a meeting of NATO defense ministers. He said:

"I'm going to make recommendations on a simple, limited first step basis, and then on a simple, limited second step. This is going to grow, rather than have some great overall plan that is going to be approved all at once."

Best informed guess is that he will say NATO's "first step" requirement is six to ten IRBM units—squadrons or battalions—composed of about 15 weapons each. In other words, the SHAPE commander may ask for between 90 to 150 IRBM weapons.

This requirement would include those IRBM bases to be established in the United Kingdom. Norstad is on record that he doesn't need nor want IRBM sites in every NATO nation. Sites in the U.K., the Franco-Italian Alps region, and northern Turkey are high on the priority list. Many of these NATO IRBM sites may be mobile.

Once Gen. Norstad's recommendations are made and accepted by NATO Council, then U. S. government will step in and negotiate bilateral agreements with those countries singled out by Norstad for missile sites. These negotiations will have to work out the tricky question of control. Most NATO nations want at least joint control over use of the IRBMs.

If the pending East-West summit conference fails to achieve any real settlement of the cold war, then SHAPE officials think deliveries of Jupiter and Thor type weapons to European NATO members may get underway early in 1959. Biggest headache may prove to be training of non-U. S. units in the operation of overall missile delivery systems.

Last November, at the annual NATO parliamentary session, an advisory gathering of NATO country politicians, U. S. delegation proposed establishment of a NATO defense missile training center as well as a North Atlantic institute for defense studies. The proposal was part of a $10 million U. S. program to beef up NATO's interest in modern weapon technology.

While main missile interest today revolves around IRBM, this year deliveries to various NATO forces of Honest John, Matador and Nike missiles are expected to begin. Up to now, only U. S. and some British forces in Germany have had such tactical weapons.

The advent of missiles into the NATO picture likely will affect the role of air power in NATO's mission, though not until the early 1960s. At the moment NATO planners are faced with an aircraft re-equipment problem. The bulk of NATO's air force is made up of Republic F-84Fs and RF-84Fs as well as North American F-86Ks.

Air Power Gains

During 1957 NATO's combat air power gained somewhat due to further deliveries of MDAP F-84Fs and RF-84Fs to Greece and Turkey. Also, continued deliveries of North American F-100C Super Sabres were made to U. S. units in Allied Air Forces, Central Europe.

USAF during the year reorganized its NATO air contribution by eliminating the 12th Air Force which was getting top-heavy on the administrative side. Air combat units of the 12th remain on the job, but under a more streamlined setup.

USAF contribution to Allied Air Forces, Central Europe, remains at about 10 wings, including two tactical missile squadrons equipped with Martin Matadors. Front-line aircraft include F-100s, F-86Ks, F-84Fs and RF-84Fs types. During the year Douglas B-66s continued to phase out Martin B-57s while Lockheed C-130 Hercules transports took over the chores of C-119s.

RAF's main contribution to NATO air power in Europe remains the Second Tactical Air Force. No new aircraft came into the Second during the year, except later Marks of the Hawker Hunter.

Canada's 12 squadrons in central Europe now include four equipped with Avro CF-100 all-weather fighters. French contribution remained unchanged during the year, consisting mainly of Mystere IVAs. Promised Sud Aviation Vautour fighter-bombers still haven't gone into NATO pool.

Luftwaffe

German Luftwaffe hasn't as yet gone operational, but it should move into the NATO picture this year. In addition to MDAP F-84Fs, German contribution may include the most modern aircraft on the NATO front line. This will happen if the German Air Ministry this spring finally decides on the type of aircraft it will buy. In the running are such types as Republic F-105, Grumman F11F Tiger, Lockheed F-104, as well as European aircraft such as the Mirage 11 and Swedish Saab J35.

During the year, Gen. Norstad ordered installation of a new radar system comparable to the North American DEW line. New, near jam-proof network will combine over the horizon tropospheric forward "scatter" and line-of-sight radio relay links. System, to be completed next year, will be capable of tracking aircraft 100 mi. behind the Iron Curtain.

New radar installation is part of a new $630 million infrastructure program to cover needs through 1961. By that date NATO will have spent some $3 billion on infrastructure, including the construction of 150 airfields and the near completion of a 5,300-mi. NATO pipeline to service these airfields. By the end of this year an additional 40 airfields should be completed.

On the ground, NATO still is shy of its 30-division goal. About five German divisions are moving into the line, with another seven to come. In all, Gen. Norstad has about 19 divisions now but the size and equipment of these divisions vary a good deal.

Norstad, an Air Force man, still refuses, despite current European desire to cut down NATO ground troop forces, to scale down his demand for a "shield" of at least 30 divisions

WHAT KEEPS IT ON TRACK?

Keeping America's missile program on the right track is one of the electronic industry's most important jobs. Andrea, with some of the best talent and facilities in the field is doing its part to help.

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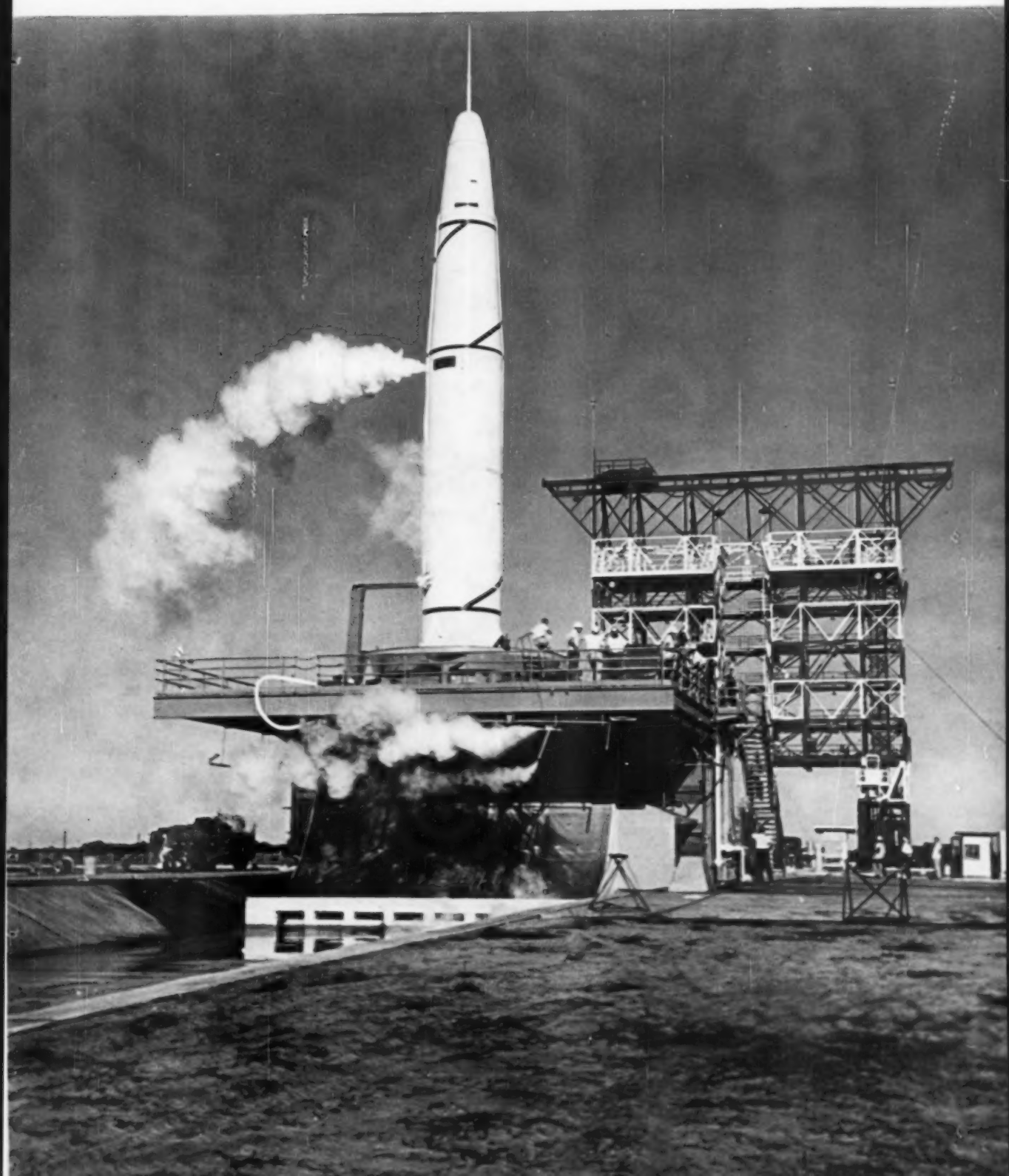
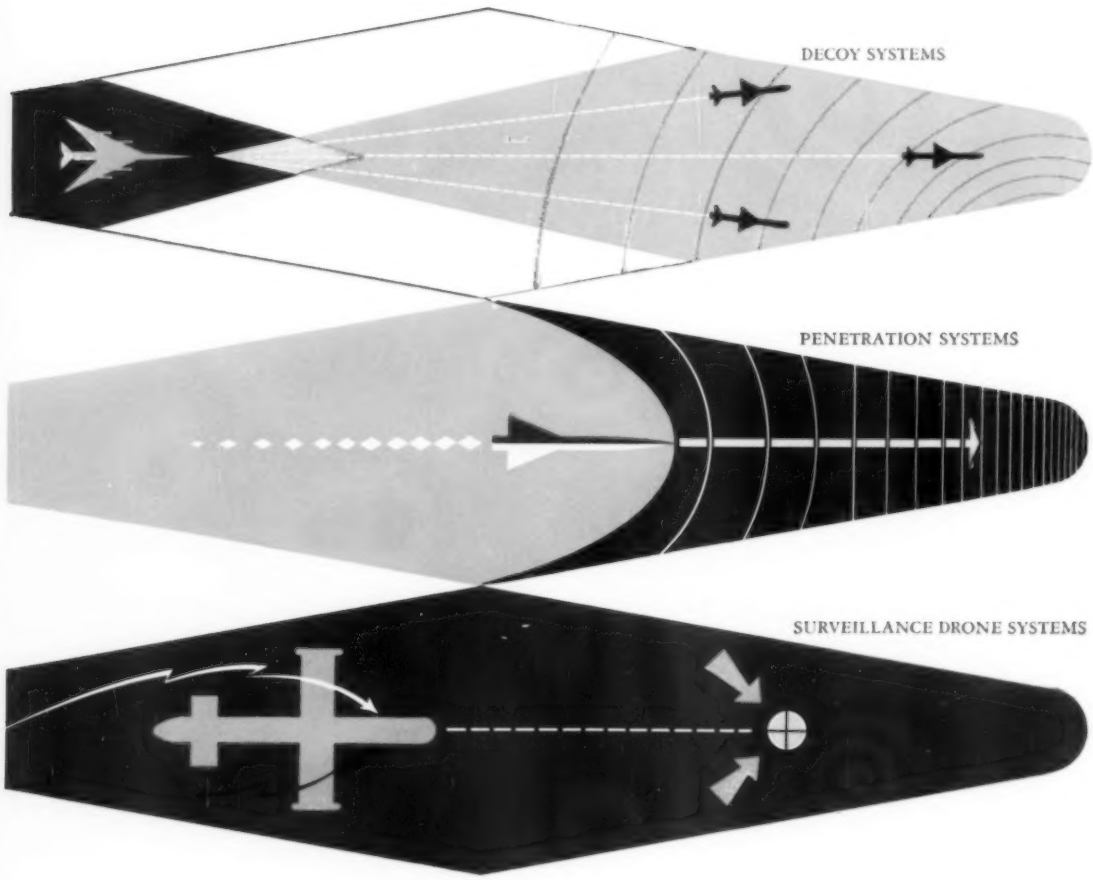
Missiles....

Douglas Thor SM-75 IRBM



DRONE and SMALL MISSILE SYSTEMS

The research and development activity at Rheem Aircraft Division has a record of achievement in the field of drone and small missile systems. The capability for complete "program management" is manifested in the list of current and completed projects and the areas of responsibility covered.



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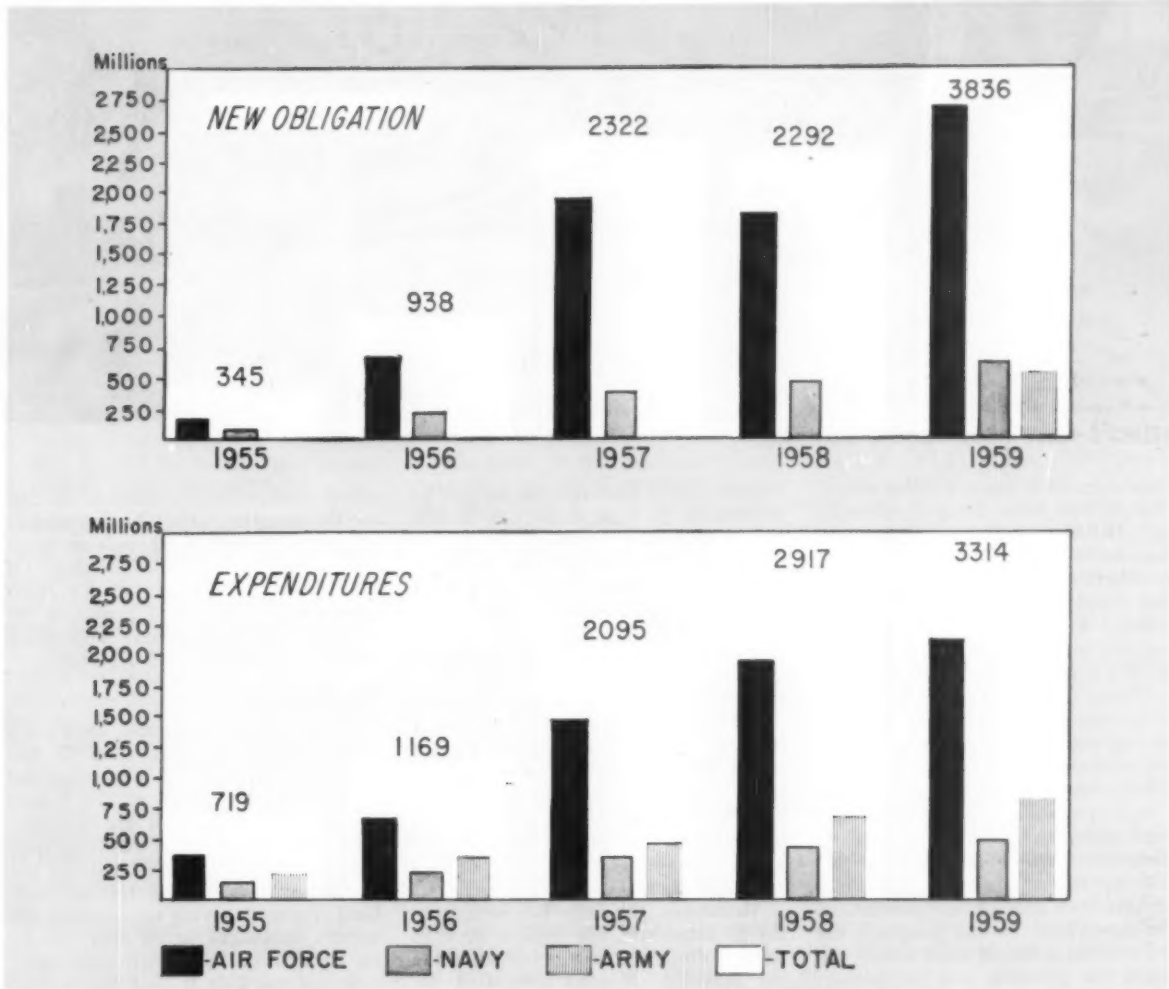


Missile Spending Spurred by Soviets

By Michael Yaffee

On Oct. 4, 1957, Russia launched the first artificial Earth satellite and cracked the composure of the Western world wide open. On Nov. 3, Russia launched a second and much larger satellite; and, for the first time in its history, the United States public began to doubt its own scientific superiority and invincibility.

It wasn't the satellites in themselves that shook the psychological foundation of the West. It was the ballistic missiles that the Soviets were apparently using to place them in orbit. These satellite carriers came as no surprise to U. S. military men who had been watching Russian IRBM and ICBM tests for over two years with long-range radar based in Turkey (AW Oct. 21, p. 26). But it caught the man-in-the-street unawares and left him bewildered and a little frightened.

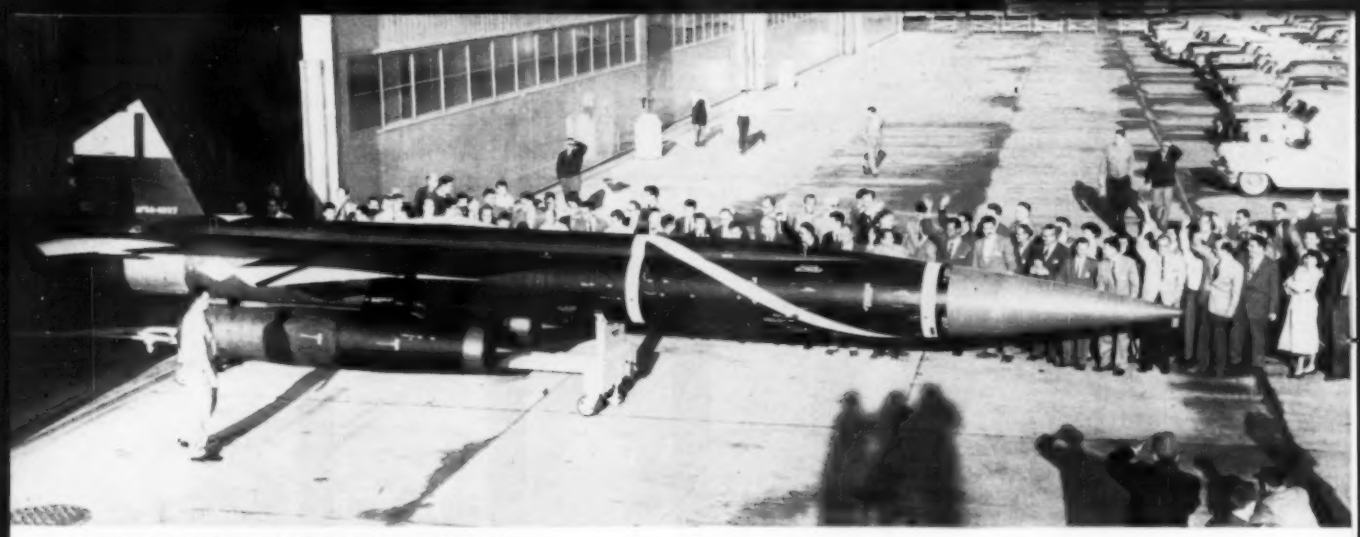
It also caught the U. S. defense effort corseted by stretch-outs and rigid budget ceilings. But a frightened populace was soon able to effect what a small group of military and industry leaders had long been trying to do. The $38-billion ceiling on the defense budget was removed. In January, Congress added $1,260 million in new money to the Fiscal 1958 defense program and transferred $150 million to defense from unexpended funds in other programs.

Most of this new 1958 money was earmarked for missiles. At the same time, Congress approved a record $3,314 million budget for missile spending in 1959—almost $400 million more than 1958 expenditures and $1,219 million over 1957 spending. And there are indications that this nation's missile bill will continue to go up as the result of increased spending on current programs, the initiation and development of new projects, and the general rise in costs that is affecting all price tags.

Here, in somewhat more detail, is a look at the major projects on which the United States is and will be spending its missile dollars and a brief indication of where these projects stand in relation to their Soviet counterparts.

IRBMs

The United States is definitely behind Russia in this area. Estimates on the size of the lag vary from two months



BOEING'S FIRST PRODUCTION BOMARC

to two years. Best guess is about a year.

Russia has been firing 1,000-mile-range IRBMs regularly for the past two-and-a-half years. There is every reason to believe that Russia has an operational missile in this category. The first successful firing of a U. S. IRBM, a Thor, did not take place until September, 1957. In all, the U.S. has fired 11 Thors, five of which were "completely successful" and seven Jupiters, three of which were considered complete successes.

Much progress has been made in both programs; for example, the critical re-entry problem appears to have been solved (at least for these two 1,500-mile-range missiles). Both missiles have been ordered into production.

In its ballistic missile program, the Air Force has followed what it calls calculated risk planning and the concurrency concept. This means that all missiles from the first test model on are turned out on a regular production line and that the Air Force spends money on launching sites, ground handling equipment and personnel training while the missile is still under development. The policy is paying off in reduced lead time. The Air Force expects to have at least one completely operational Thor squadron ready for deployment overseas by the end of this year.

Jupiter Development

Jupiter development trails Thor by about a year. In January, Chrysler received a $30 million contract for Jupiter components and ground-support equipment. From the new supplemental 1958 funds, another $30 million was slated for Jupiter research and development along with an additional $171 million for acceleration of the operational capability of both Thor and Jupiter. On a production basis, each Jupiter will cost about $1 million, sans warhead. (Compared to about $800,000 for a Thor.) Production is expected to be underway in Detroit by the end of the year, at the rate of four to five missiles a month.

Use of both missiles has been assigned to the Strategic Air Command. But this decision is no more to the Air Force's liking than it is to the Army's. The Army still believes it has a right to use long range missiles. The Air Force sees little sense in spending time and money on the Jupiter when it already has what it believes is a superior weapon in the Thor almost at the operational stage. And there are indications that Defense Secretary McElroy is taking a long hard look at this Defense Department decision, with the idea of possibly abandoning the Jupiter.

Meanwhile, the Army has been given the go-ahead and $20 million in 1958 transfer funds for the development of the Pershing. A solid version of the Redstone, this missile may reach an 800-mile range capability. It could keep the Army in the long-range missile class and compensate for its separation from the Jupiter.

Polaris

The Navy is steaming ahead on development of the 1,500-mile-range Polaris. Two test vehicles have been fired, and the fleet ballistic missile program is reportedly passing milestones as though they were inch-markers. The submarine-based IRBM is expected to be operational in 1960.

The Russians are reported to be working on a long range, submarine-launched ballistic missile also. Tagged the Comet II, it is said to have a range between 500 and 1,000 miles. Scanty as available information is, the FBM race appears to be fairly close.

Considered a second generation missile, the Polaris is one missile that has never lacked adequate funds. The Navy considers it its top priority weapon system. The original contract was for $20.5 million. Last October, the Navy added another $62.1 million to accelerate the program. And the program is scheduled to get $350 million more from supplemental FY 1958 funds. Of this, $296 million will go for three atomic submarines; $22.2 million for research and development; and $31.8 million for missiles and facilities.

Beryllium Use

A solid propellant missile, the Polaris is designed for launching from the surface or submerged. An interesting and significant outcropping of the Polaris development program is the beryllium work. Beryllium is an excellent high temperature-high strength material but is difficult to work and brittle. Lockheed is actively trying to overcome the metal's drawbacks in an effort to use the material for the Polaris nose cone.

Russia has fired at least two ICBMs successfully, not counting the one that was successfully adapted as a carrier vehicle for the second Soviet satellite. (The Sputnik I carrier is believed to have been an IRBM.) Again, lack of adequate intelligence prevents a detailed evaluation of the Russian ICBM program, but many experts believe that Russia's 5,000-mile-range missile will soon be operational. First American ICBM, the Atlas, isn't scheduled to be operational until December, 1959.

To date, the Air Force has fired five Atlases, two of them successfully. The two successes, however, were not full range tests; and only two of the missile's three engines were used. The main motor was not fired. Nevertheless, the tests provided much valuable data and demonstrated workability of the vernier engines used for trajectory control.

The second American ICBM, the Titan, is considered a much more sophisticated missile than the Atlas. It is about a year behind the Atlas in development. The first flight test of the Titan is scheduled for next October but may be moved up as the program is

accelerated. Despite the adjustment in the 1958 budget, many Air Force men believe the top priority Atlas and Titan programs still lack adequate funds and could be stepped up even more.

Back in 1953, the U. S. spent $1 million on all ballistic missile development. By 1957, this figure rose to $1 billion. The original budget for ballistic missiles in 1958 was about the same. Later, however, the Fiscal 1958 ballistic missile budget was considerably fattened by supplemental and transfer funds.

Items: $60 million for Jupiter; $171 million for Thor and Jupiter; $116 million for Polaris (not including submarine construction); $120 million for Atlas, $166 million for Titan and anti-missile missile programs; $112 million for Air Force ballistic missile sites. Fiscal 1959 request for ballistic missiles is expected to top $2 billion.

Anti-Missile Missile

The important group here is the anti-missile missile. The three weapons originally in this group were the Air Force's Wizard, the Army's Nike-Zeus and Plato, a mobile defense system based on the Nike-Zeus.

In January, the Defense Department chose the Nike-Zeus over the Wizard, ordered the Army to move ahead with its development "as a matter of urgency." The Air Force was ordered to discontinue all work on the Wizard except the part that pertains to radar and data handling aspects, including its relationship to SAGE and other radar capabilities.

At the same time, control of all anti-missile work was handed to the Advanced Research Projects Agency. Funds for the Army's anti-missile work will be credited to the ARPA budget while the Air Force will retain Wizard money in its own account.

First money to appear in the budget for this work showed up in the original Fiscal 1958 budget under Army research and development. It was for $12 million. Now the ballistic missile detection program is scheduled to get an additional $329 million from supplemental 1958 funds: $160 million for three long range radar detection stations to be built by the Air Force; $169 million for acceleration of the program. Fiscal 1959 budget, as it now stands, allots another $320 million for this work.

The first Nike-Zeus is not expected to be operational before 1964. There is no reason to believe that Russia is any more advanced in this area than the U. S. Projected kill probability of Nike-Zeus against ICBMs has been pegged at only 25% at present.

In the more conventional surface-to-air missiles, the U. S. probably has a slight edge over Russia. Deployment of the nuclear-tipped Nike-Hercules significantly strengthens air defense capability. Together with the Nike-Ajax, it provides fair high altitude coverage against subsonic aircraft. Meanwhile, the Army is moving the Hawk in to fill the low altitude gap.

Another important addition here is the Bomarc interceptor missile with a range of 200 miles. The missile has been launched automatically by a control station over 18 miles away from the launching site, destroying a drone more than 100 miles away. The Air Force claims the missile approaches the ultimate in automaticity and is integrating it into the SAGE system.

The Navy is working on an improved version of the Terrier which is expected to be operational next year. The smaller Tartar is scheduled to go to sea the following year. The Navy hopes to have the Talos in operation this year and an extended range version in 1959. The Army is continuing development and evaluation of a land-based version of the Talos.

This is one category the Russians appear to have neglected while the United States has pushed it fairly hard. Sitting ducks for an effective anti-aircraft missile, these 700-mph. air-breathing missiles nevertheless provide the U. S. with a valuable interim offensive capability.

With the cancellation of the Navaho ramjet last year, all missiles in this category are now turbojet-powered. Their range capabilities run from about 600 to 5,000 miles.

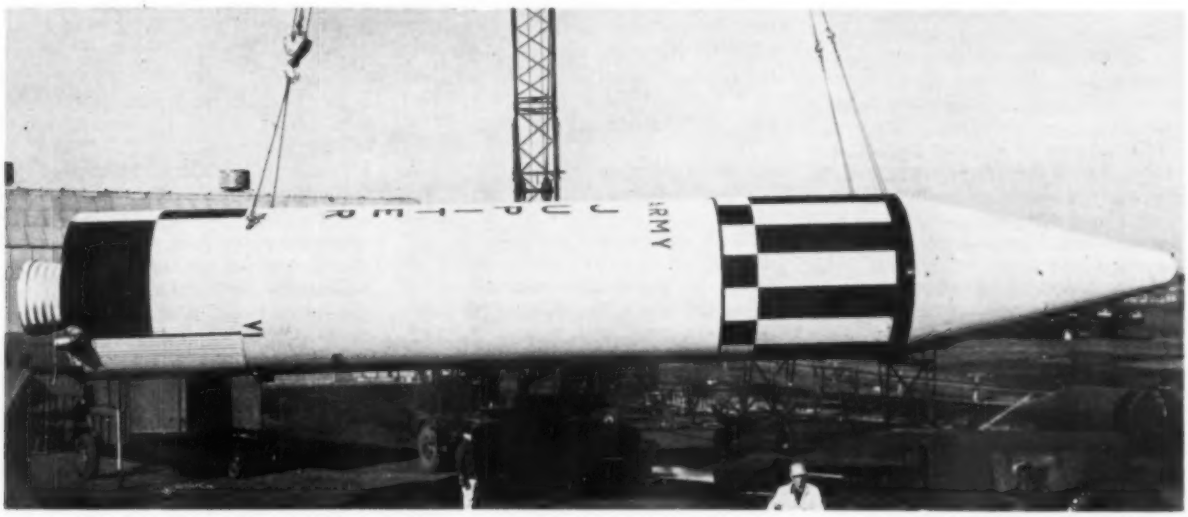
Achievements

Among the more notable achievements in this category in the past year have been the full 5,000-mile-range tests of the Snark and the activation of the first operational Strategic Air Command unit to employ the missile. Not as glamorous a weapon as the ballistic missile, the Snark nevertheless is a worthy complement to manned aircraft and, in the words of one Air Force general, "significantly increases the USAF's current deterrent capability."

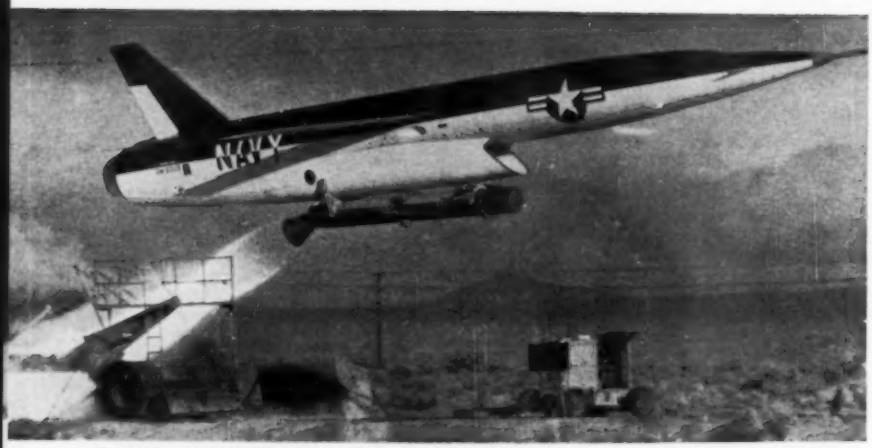
Another Air Force subsonic missile, the Matador, has been steadily improved over the last year. A new version of the missile, called the Mace, uses an inertial guidance system, has a 650-mile range, and can fly over 650-mph. at altitudes above 40,000 ft.

The Navy's 500-mile-range Regulus I is now operational. A much improved model, the Regulus II, is currently undergoing flight tests and is slated for sea duty in 1959. Regulus II is faster than Regulus I and has a 1,000-mile-plus range.

Few missile men consider the air-breathers as anything more than stop-gap weapons, existing on borrowed time. But continuing improvement in ramjet



ARMY'S JUPITER IRBM



ROCKET-BOOSTED CHANCE VOUGHT REGULUS II

and turbojet Mach capability coupled with the air-breathing engine's comparatively greater reliability and fuel economy could keep this class of missiles competitive with their ballistic counterparts for some time.

Other Missiles

In most of the other missile categories, there is no reason to believe that Russia is ahead or even abreast of the United States.

In air-to-air weapons for example, the Falcon, Sparrow and Sidewinder series of missiles, using radar or infrared guidance, are undoubtedly as good as anything the Russians may have. The nuclear armed Genie, now operational with interceptors of the Air Defense Command, as yet appears to have no Soviet counterpart.

Last year, the Air Force activated the first SAC B-47 units using the Rascal. The Hound Dog, a new air-to-surface missile with greater range than the Rascal, is now under development and destined for use with the B-52 along with new diversionary missiles now under development such as the Green Quail. And after this, says the Air Force, will come air-to-surface ballistic missiles.

The Army is moving ahead at a steady clip on the development and employment of short-range (200 miles and under) ballistic and guided rockets. These include Honest John, Little John, Corporal and Redstone. About 1960, the Army expects to replace the now-operational Corporal with the longer range Sergeant.

In the air-to-underwater (or, more precisely, the anti-submarine) group, the Navy has a number of missiles under development to replace the Petrel, now phased out to reserve squadrons. These new weapons include air-launched, surface launched, and underwater-launched missiles.

The advent of Sputnik I is undoubtedly the most notable event of the past year. Not so much because it went into orbit, but because of the chain reaction it initiated.

Had the U. S. been able to foresee the impact the event was to produce, there is little question that the Administration would have diverted a number of IRBMs for service as satellite carriers and, perhaps, thereby have beaten Russia into space.

Instead, the Naval Research Laboratory was pressured into turning Vanguard test vehicles into a resemblance of a finished satellite project with dismal publicity results. Then the Army Ballistic Missile Agency was called in, rigged up a Jupiter-C, and sent Explorer I into orbit. The rejoicing of the Western world was tremendous and unwarranted.

Jupiter-C

All Jupiter-C proved was that enough rockets could be put together to put a satellite in orbit. It was in no way a match for the Sputnik carriers nor, for that matter, even for the Vanguard vehicle. If there was any significance to the Jupiter-C launching, it lay with the new hydrazine-based high energy fuel used in the Redstone first stage.

Also, of course, Explorer I lowered the starting flag on the interservice race for space. As this race now stands, the program and contestants are as follows:

• **Naval Research Laboratory** is still working on the Vanguard program, intends to fulfill its commitment of launching a satellite during the International Geophysical Year.

• **Army was given go-ahead** to launch Explorer II. The Army also has plans to launch big military reconnaissance and mapping satellites "far larger" than those possible with the Jupiter-C, according to Army Secretary Wilber Brucker.

• **Air Force is already at work** on a military reconnaissance satellite which would have a detachable capsule to return records to Earth. Using Thor as a booster, the Air Force hopes to have the satellite in orbit early next year. The Air Force also plans to send a payload to the Moon this year by coupling a Thor first stage with second and third stage from either Vanguard or the X-17.

• **In December, 1957,** the Air Force set up its Directorate of Astronautics, the first organized group to plan and manage space programs. The Defense Department quickly checked this group, moved ahead with its own space agency.

• **As originally drafted** by the Defense Department, the purpose of the Advanced Research Projects Agency was to combine research and development on all new weapons under a single manager, starting with work on the anti-missile missile.

In January, ARPA was given responsibility for the Air Force Pied Piper reconnaissance satellite program and for the Nike-Zeus and Wizard programs. On Feb. 7, a little over two months after the conception of ARPA, General Electric's Roy Johnson was named the first director of the agency.

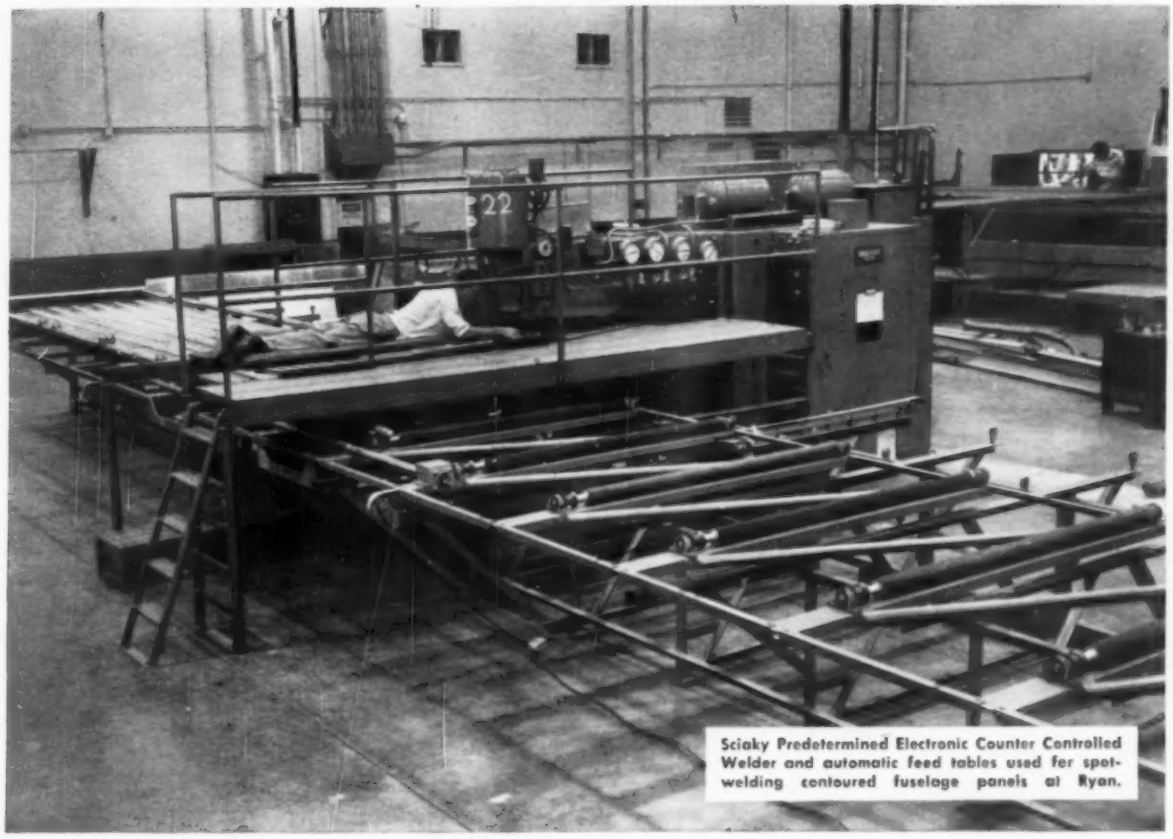
• **National Advisory Committee for Aeronautics** established a special committee on space technology early in January composed of leading U. S. scientists. A month later, NACA detailed its comprehensive proposal for a national space flight program. NACA would assume a role similar to the one it has played in aeronautics for the past 42 years.

The NACA plan has picked up strong backing from among scientists, military and industry leaders. In addition, Defense Secretary McElroy has indicated that ARPA would favor collaboration with NACA rather than with a new civilian unit patterned after the Atomic Energy Commission.

• **Atomic Energy Commission** also feels that it has a stake in space. The Commission believes that nuclear engines will someday power all space craft and is now at work on atomic powerplants for a ramjet, rocket, and reconnaissance vehicle.

• **President Eisenhower requested** his Special Assistant for Science and Technology, James Killian, Jr., to make a survey to show how the Government should organize its space activities.

• **Congress approved ARPA,** saying it can have charge of military space programs indefinitely but limiting its control of any nonmilitary space programs assigned to it by the President to only one year. During this year, Congress intends to formulate its own program for control of space activities. It has indicated its readiness to listen to any recommendations that Dr. Killian may come up with. There are other indications that Congress will favor a new



Sciaky Predetermined Electronic Counter Controlled Welder and automatic feed tables used for spot-welding contoured fuselage panels at Ryan.

COMPLEX SPOTWELDING PROGRAM AT RYAN IS SEVERE TEST FOR NEW SCIAKY COUNTER CONTROL

Ryan Aeronautical Company, San Diego, California has achieved a significant first in resistance welding—automatic spot welding of large contoured fuselage panels for the Boeing KC-135 and "707" Jets.

Referring to their new Sciaky Counter Controlled Welder, Mr. Bob Fullerton, Ryan's Senior Welding Engineer, stated, *"This is one new welding development that really does what the advance announcements promised."*

PRECISE CONTROL

Early in the program, it became obvious that precise control of all welder functions and absolute production consistency of welding was essential. Introduction of the new Predetermined Electronic Counter Controlled Welder by Sciaky helped solve this problem.

Here, for the first time, is a welder in which functions are controlled to a fraction of a cycle of alternating current. Control settings are realized with exactness. The unvarying accuracy of counting is maintained throughout the entire range for the longest run at the highest production rate. Any production control setting is readily reproducible at any time.

CONSISTENT, SAFE WELDS

The consistently safe welds produced by the Sciaky Counter Weld Control are essential to the Ryan program since the skin is a load-bearing member. In addition, the size of the assembly—largest every sub-contracted in the industry—will not tolerate even the possibility of rejects due to imperfect welds.

The importance of consistently perfect welds is emphasized by the tremendous number of spotwelds in the aft fuselage sections of the Boeing jet tanker-transports. Approximately 77,000 spot welds are required to join skins to skins, skins to doublers and stringers, and bulkhead components together.

TAPE COMMAND OF WELDING OPERATIONS

Welding operations on the various assemblies can be controlled by a tape command unit providing complete piece part positioning in all directions. Automatic interlock between positioner and welder is required. This would provide more automatic operation.

COMPLEX TOOL-UP

Handling and positioning the aluminum skins also presented a major problem. Ryan solved this by installing huge positioning tables with push button controls to permit automatic feeding.

The characteristics and consistent operation of the Sciaky Counter Controlled Welder combine perfectly with the automatic abilities and consistency of the Ryan positioning table to satisfy the requirements of this complex production assembling operation.

LITERATURE AVAILABLE

Technical bulletins completely describing the new Sciaky Predetermined Electronic Counter Weld Control are available. Write on your company letterhead requesting Bulletins 338 and 339.

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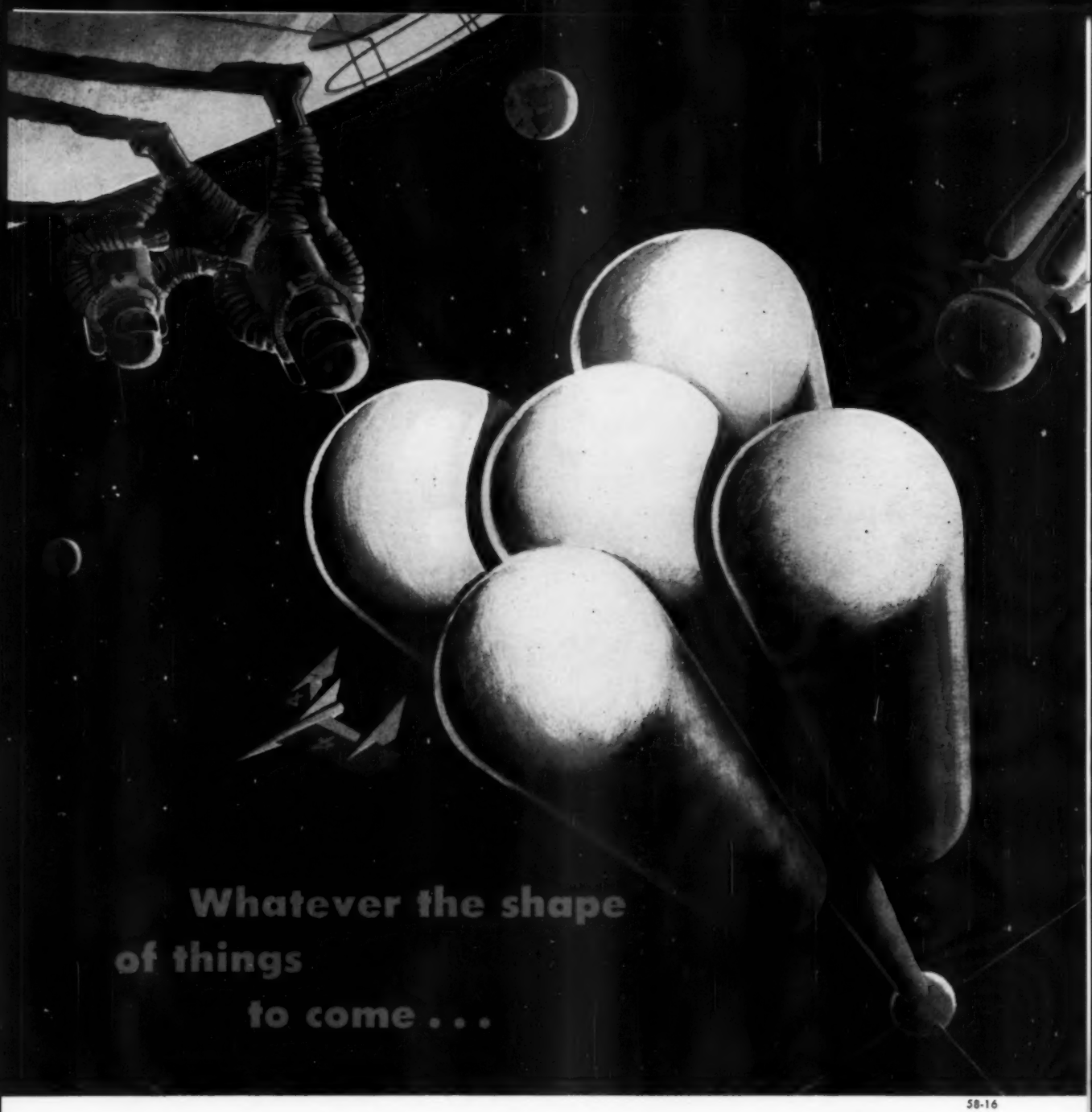

58-16

Fantastic shapes for the space vehicles of the future already are on the boards. Even more radical designs are taking form in the minds of engineers. And their parts and components will just as radically differ from those produced today. New standards of precision and new methods of working new materials will be required.

One thing at least is certain: the same design, development and manufacturing experience which made the transition from aircraft piston engines to jets will be needed to produce these shapes of the future. Since the early 1920's, Ex-Cell-O has been among the major suppliers of machines, parts and assemblies to the aircraft industry. In that time it has built a reputation for extending the frontiers of precision.

Today, Ex-Cell-O manufactures such components as: rotors, blades, fuel nozzles, actuators, valves and fuel controls. Tomorrow? Well, perhaps you yourself have a problem which Ex-Cell-O's long experience in the production of precision controls and assemblies might help you solve. If so, why not contact Ex-Cell-O today?

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Aircraft Division

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MAN AND MISSILES FLY HIGHER, FASTER AND SAFER WITH PARTS AND ASSEMBLIES BY EX-CELL-O.

space agency patterned after the A.E.C.

The Senate has already created a new Senate committee which will frame space legislation.

The resolution specified that members of the new committee be drawn from the six standing committees having jurisdiction of various phases of space development. The standing committees referred to were Appropriations, Armed Services, Atomic Energy, Foreign Relations, Government Operations, and Interstate and Foreign Commerce.

Propulsion

The launchings of the two Soviet Earth satellites have led many missile men to believe that Russia has an operational 250,000-lb. thrust rocket motor. Even those that doubt this generally concede that Russia is markedly ahead of the United States in this area.

Some informed sources believe that the big Russian motor is fueled by a high energy liquid chemical, possibly akin to the hydrazine-based Hydyne used in the first stage of the Explorer I carrier. To date, the largest operational liquid propellant rocket motor possessed by the United States is the 165,000-lb. thrust Thor engine, which is the same powerplant used for the Atlas boosters.

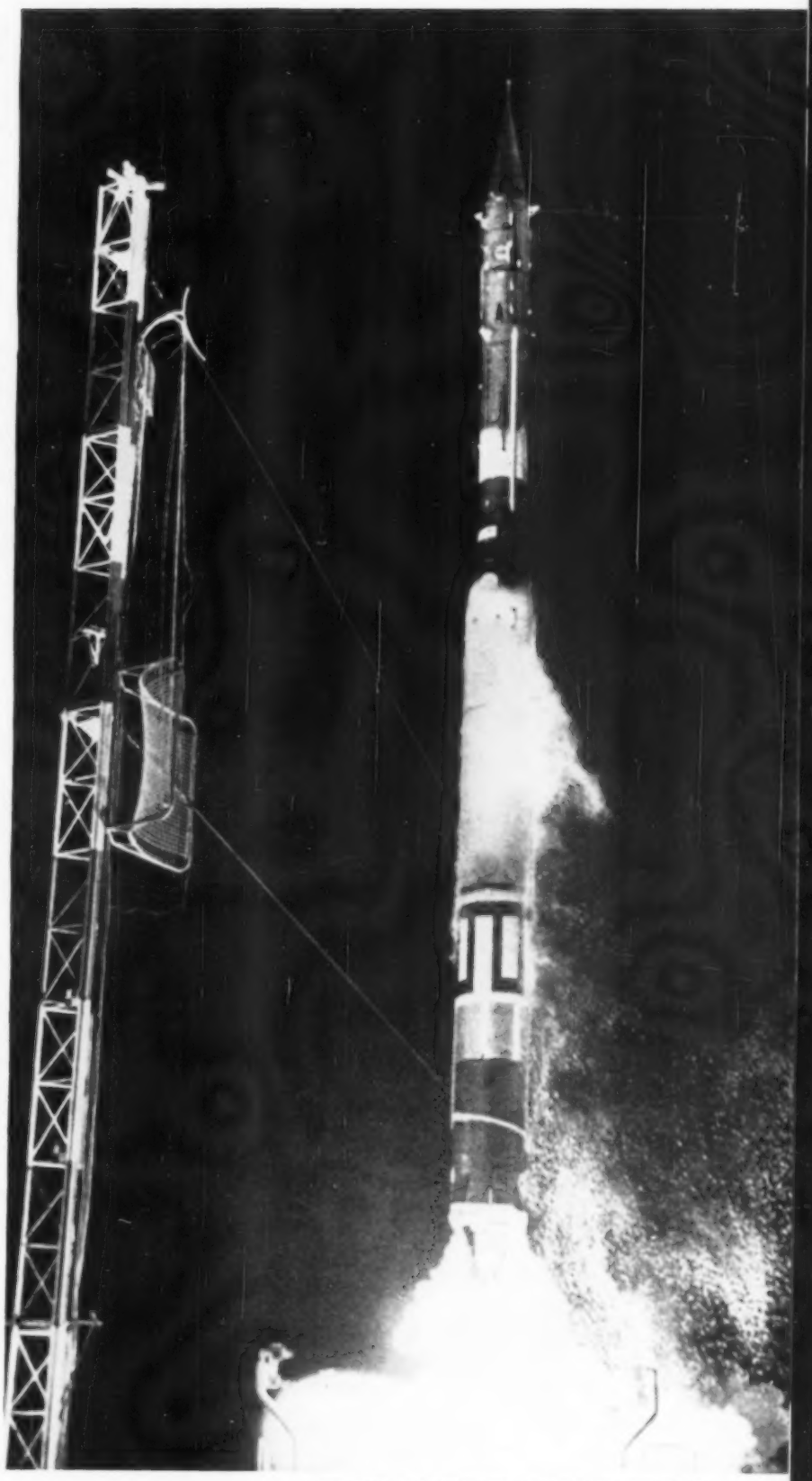
The U. S. is working on the development of a one million-lb. thrust motor but is not expected to have such an engine in operation before Russia. Of more immediate significance is the new solid propellant rocket now under test by the Air Force. This is claimed to be the largest solid propellant motor.

There is a large group of people that is convinced that solids will soon be the basis of almost all missile propulsion systems. Another group says definitely not. They yield the small missile field to the solid motors and concede them equal billing in the medium thrust field. But when it comes to large rocket motors, they say, solids start increasing in complexity and handling difficulty to the point where they soon lose any advantages they once had over liquids.

Liquid Best?

At the same time, the liquid advocates claim they have reached the point where they are beginning to simplify engine operation and improve reliability. Another point in their favor, they add, is that new, high energy chemical such as hydrazine and its derivatives, the boranes and fluorine, are sooner adapted as liquid propellants.

There is no question, however, that solids are moving into many jobs that once were held exclusively by liquids. And, considering the inherent gamble in missile production, most engine makers don't want to take any longer odds than they have to and would like to



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AEC Projects

The Atomic Energy Commission is now in the missile field. At present, it has three major programs underway on the development of nuclear propulsion for unmanned vehicles. They are:

- Project Rover, an atomic-powered rocket.
- Project Pluto, an atomic-powered ramjet.
- Project Snap, a newly disclosed program that is said be closely related to the Air Force's Pied Piper reconnaissance satellite project.

cover themselves no matter which way propulsion goes.

In a move to get back into the solid propellant field, for example, North American joined forces with Phillips and set up a jointly owned firm called Astrodyne, Inc. to specialize in solid propellant work. An earlier effort in this direction was carried out jointly by Reaction Motors and Olin Mathieson last summer.

The high energy fuels provided the impetus for another series of moves. Aerojet-General and Stauffer Chemical formed a joint partnership called Stauffer-Aerojet Co. to carry out development of the new boron-based chemicals. Thiokol signed a working agreement with Callery Chemical on the development of solid boron propellants. American Potash & Chemical Corp., Food Machinery & Chemical Corp. and National Distillers & Chemical Corp. jointly formed AFN to work on high energy propellants.

To survive among this formidable competition being built up in the propulsion field, Thiokol merged with Reaction Motors, and Grand Central Rocket Co. moved under the protective corporate wing of Tennessee Gas Transmission Co.

A large number of major missile and aircraft firms, looking to the future, have entered the nuclear energy field in one way or another.

Included among such companies are Aerojet-General, North American, Martin, Lockheed, Convair, United Aircraft, Marquardt and, of course, General Electric.

The pattern for the immediate future of missiles has already been established by the events of the past year. Among the more evident trends now in progress are the following:

- **Increased spending** for missiles at the expense of more conventional weapons with an end to rigid budget ceilings. There will be an accompanying growth in basic research.
- **Acceleration of most** missile programs. Major effort will be concentrated on the long range ballistic missiles and anti-

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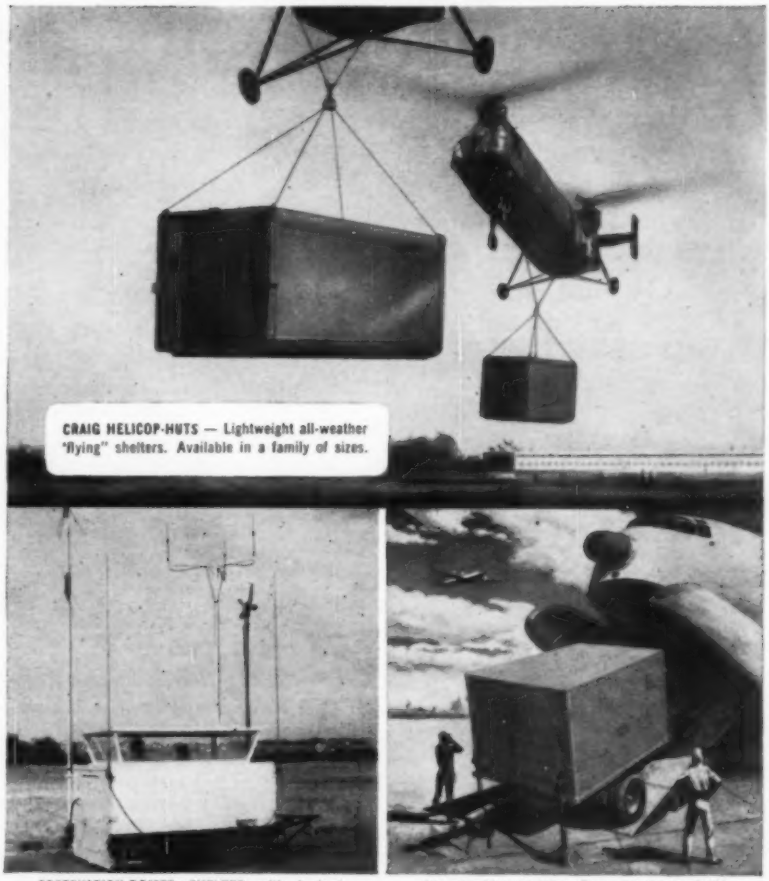

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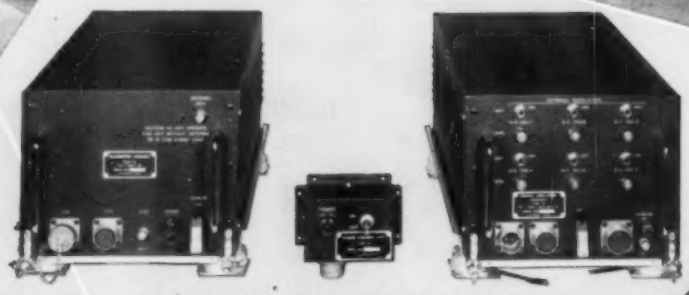
by Seeburg

but costs...speed training at Air Force Missile Test Center



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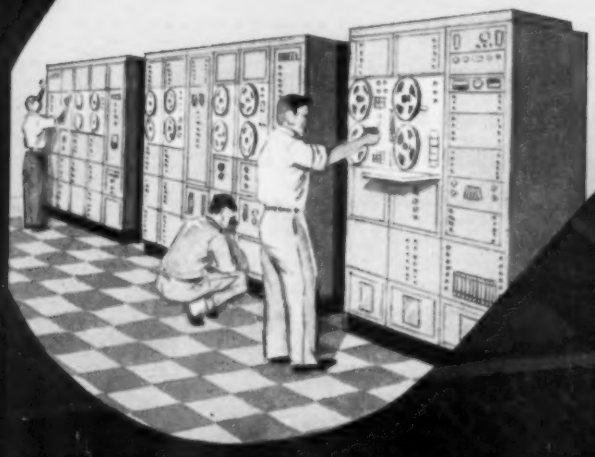

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missile missile systems. These two groups will continue to be the top priority defense projects, with anti-submarine missiles running a fair third.

• **Greater use of** solid propellants. This will go on until high energy liquid propellants are developed to the point where they are fairly easy to use and handle and offer a significant advantage in specific impulse. Too, there will be a further concentration of corporate effort in this field, with most companies offering both liquid and solid propellant systems.

• **Development of more** powerful rocket motors, both solid and liquid. And while rocket men strive for a million-lb. thrust motor, other engineers will be pushing turbojets to Mach 3 and ramjets to Mach 10. This will result in greater use of combination powerplants and of different type powerplants within the same missile.

• **Substantial increase** in the number of space projects. The first projects will be Moon shots and more sophisticated satellites. The Air Force is favored to run most of the military space programs. Non-military programs will be handled by a civilian astronautics group yet to be established.

• **Inclusion of men** in missile systems. It is generally believed that man will be able to withstand the rigors of rocket flight. More important, he can exercise an essential selective control function that his unthinking electronic counterpart can't. Upcoming flights of the Bomi, X-15, and manned satellites will more fully determine man's capability.

• **Expansion of work** on advanced means of propulsion. Development of nuclear powerplants is already underway. Interest in the more exotic systems based on ions, free radicals, and metastable compounds will grow.

• **Growing use of** inertial guidance in missiles. Also, avionics will continue to show progress in the development of infrared passive radar, and Atran type guidance systems. And as more and more missiles become operational, increasing attention will be paid to the development of improved ground checkout equipment of the "go-no go" variety.

• **Intensification of sounding** rocket development. More interest will be shown in high altitude research. The government will provide more money to groups such as the Naval Research Laboratory and the Air Force Cambridge Research Center for purchase of research rockets. And, as a result, industry will turn out more and better sounding rockets.

In total, all these developments will add up to a vastly accelerated U. S. missile program. Within five years, say the experts, the United States will be at least abreast of and, in all likelihood, ahead of Russia in the missile race.

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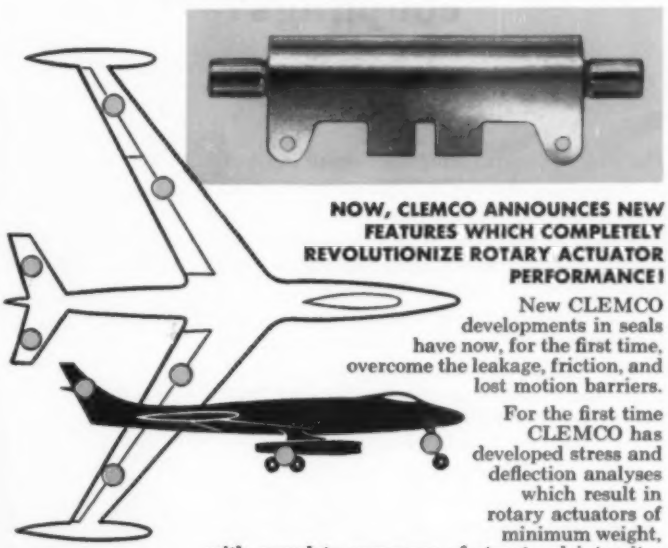

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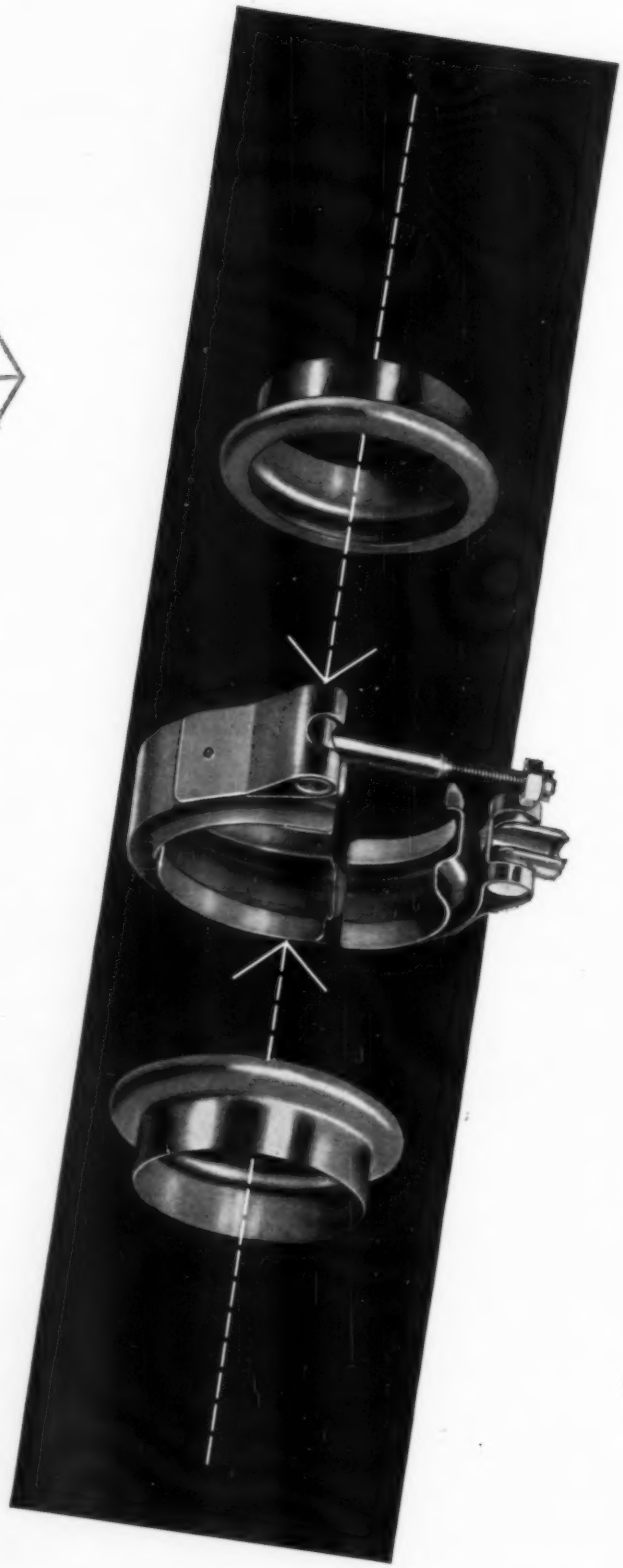

The special thing to remember about Janitrol air duct couplings is that their *aircraft reliability* is proven, both in tests and in use. A full range of standard sizes is available, and special designs can be made quickly, in aluminum, stainless steel, or titanium.

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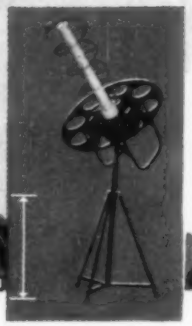
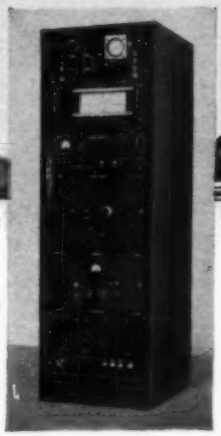


Receiving Antenna
(Tripod Height 4')



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(68" High)

	Distance from Target	Accuracy
MISSILE TRANSPONDER	0-200'	±10'
	0-500'	±10'
	0-3000'	±10'
PROXIMITY SCORERS (Adjustable)	0-100'	± 5'
	0-400'	±10'
TARGET LOCATOR ACCESSORY	0-100 mile range	± 2%
	Azimuth	± 5%
	To 70,000' altitude	± 2%

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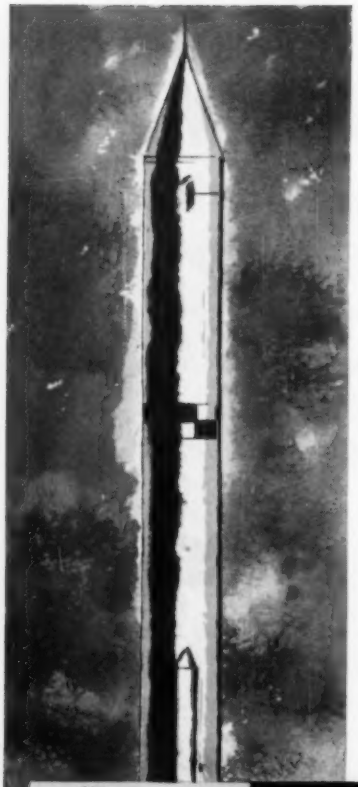

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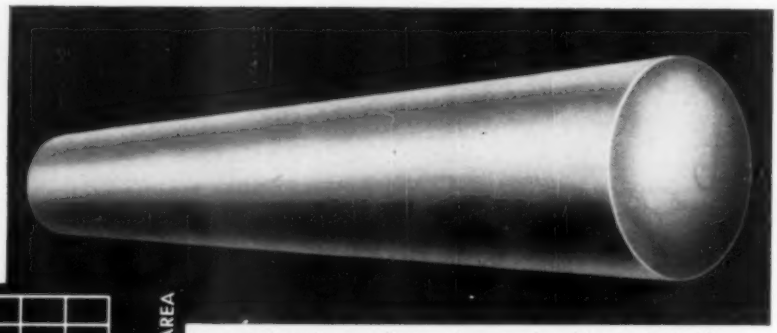
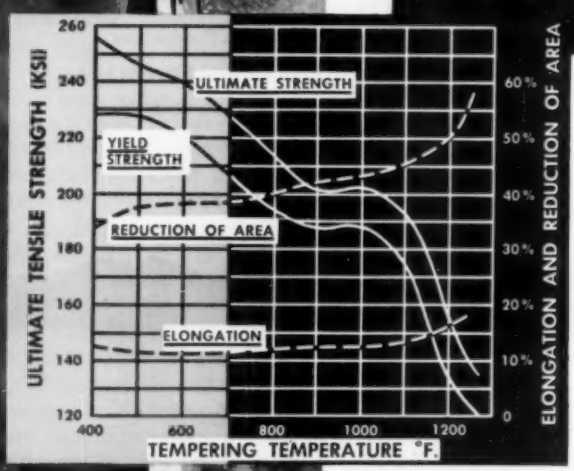


Typical missile propellant tank as produced by A. O. Smith. Diameter is 40", length 28'. The highly stressed longitudinal welds in the "roll and weld" fabrication method can be flash-welded for higher strengths.



Materials are available which will produce properties indicated above. Current light weight — hi strength propellant tanks are being produced in the strength range indicated by the shaded area of the chart.

Here's a new opportunity to gain wider design latitude. A. O. Smith can fabricate liquid or solid propellant tanks (cylindrical or spherical) and pressure tanks to practically any chamber size.

A. O. Smith has produced tanks with guaranteed minimum yield strengths of 190,000 psi. . . . wall thicknesses from .050"-.220" . . . diameters over 50" . . lengths to 28'. Proposed designs and recent fusion weld developments indicate minimum yield strengths of 210,000-225,000 psi are attainable in weld areas.

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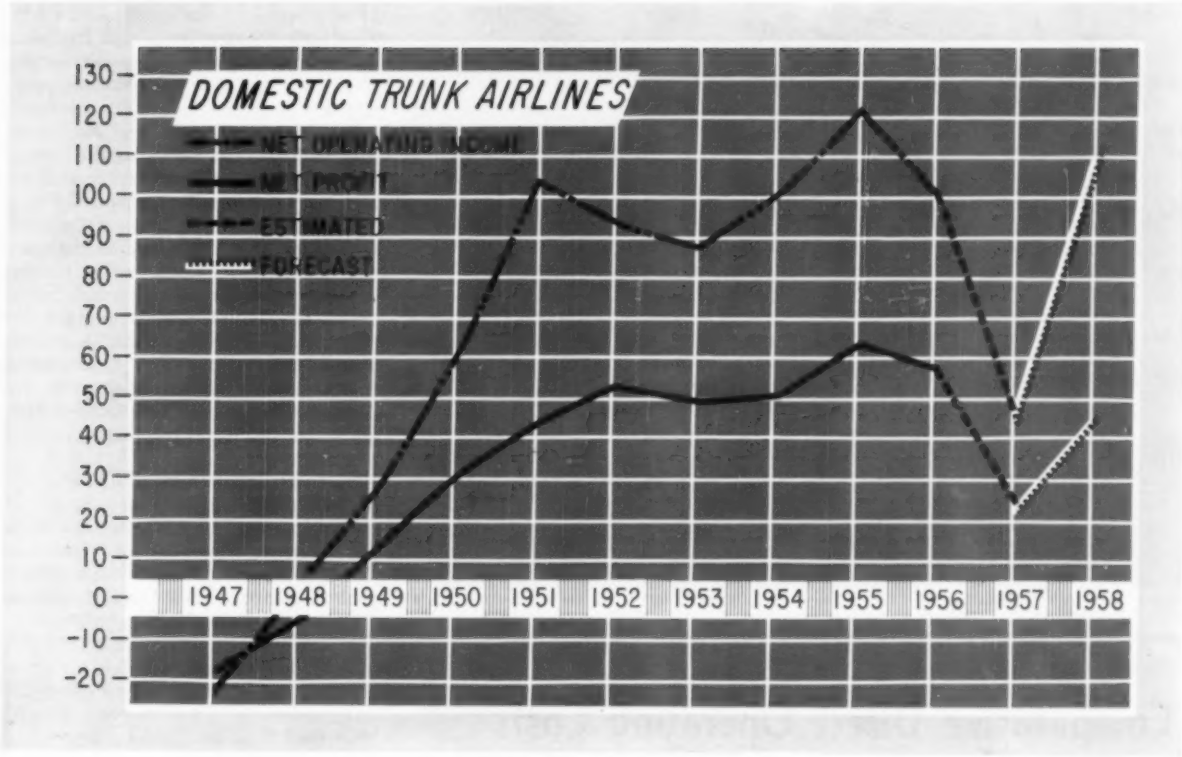


Profit Squeeze Stunts Trunk Growth

By L. L. Doty

Washington—Domestic trunklines this year face one of the most crucial periods in their history as a result of a severe profit squeeze that, in 1957, forced earnings to their lowest level in seven years.

Although the carriers handled a record volume of passenger traffic in 1957, a sudden year-end dip in load factors slashed earlier earnings which were already pinched by a mounting expense level that jumped 19% last year over 1956. Net profits tumbled to an estimated $22.4 million from $57 million in 1956—a 60% drop.

Earnings prospects for 1958 are somewhat brighter as the result of the Civil Aeronautics Board offer to hike fares by an average 6.6%. But the $44.8 million net profit now forecast for this year falls short of the earnings margin carriers say they need to finance jet equipment. Without the 6.6% fare increase, a net loss of $8.1 million was forecast by the Air Transport Assn.

However, with rising costs continuing to outpace revenue growth, the forecasted $44.8 million profit could dwindle rapidly, particularly if the current economic recession is prolonged beyond mid-summer.

The industry's financial dilemma now pinpoints 1958 as a pivotal year with the outcome of the Civil Aeronautics Board General Passenger Fare Investigation looming as a make-or-break issue. Testimony presented so far by all 12 carriers and the Air Transport Assn. during the investigation hearings has emphasized that the industry's $2 billion jet re-equipment program will materialize according to plan only if fare increases ranging from 15 to 17% are granted.

Backed by an impressive array of Wall Street bankers and investment brokers, the carriers warned the Board that the industry's ability to raise capital through equity financing is rapidly losing favor with the investing public because of low returns and high risk. The jet equipment program will begin late this year with the delivery of the first of the Lockheed turboprop Electras to Eastern Airlines.

Poor showing of airline stocks last year and a low price-earnings ratio has fended the public off from airline investments. Last year, market values of airline stocks fell below book values. In 1951, airline stocks sold at an average 50% premium above book value. By the end of 1957, Standard & Poor's 500 industrial stock index dropped 18% from 1956-57 highs but the value of airline stocks plummeted 53%.

Major carriers managed to maintain their dividend programs during the year but a number are now concerned that an actual loss after interest payments will result in 1958 unless relief in the form of fare increases is granted.

Capital Airlines, burdened with heavy interest charges covering its $68 million investment in turboprop Viscounts, petitioned the Board for an annual $18 million subsidy to rescue it from a "critical financial condition."

Although the carrier withdrew the request earlier this year as a result of new financing arrangements through General Dynamics, the action was considered by most Wall Street observers as symptomatic of the industry's deteriorating financial position.

For the industry in general, operating revenues rose 13.7% in 1957 over the year before but the 19% climb in operating expenses cut net operating income by 52.7%.

Last year, the Board turned a deaf ear to the airlines' pleas for aid and rejected a request by seven carriers for an interim, emergency 6% fare increase following the six-months-long suspended

passenger fare investigation. In the case, the Board concluded: ". . . there is no evidence as to any inability on the part of the trunkline industry generally . . . to obtain necessary financing for replacement or expansion needs."

The Board reaffirmed its decision in November by refusing to reconsider the case.

The suspended fare case thus served only to sidetrack the Board's major study—the general passenger fare investigation—which began in May, 1956, and which will continue into 1959 if allowed to run its full course.

Fare Increase

However, one Board member did suggest that a more detailed analysis of financial requirements for jet aircraft might create a more sympathetic attitude toward a fare increase. The airlines promptly obliged when the general fare investigation was resumed by laying out complete projections and forecasts of traffic volume coupled with a detailed survey of re-equipment programs.

At the same time, the airlines became concerned with the marked dip in the rate of traffic growth and the declining load factors and returned to the Board with requests for another interim fare increase—this time, for as much as 15%.

Too Little Too Late

As the flurry of requests for immediate fare increases mounted in volume, the Board, suddenly and without announcing any reason, reversed its 1957 stand and offered the carriers an opportunity to file for a fare increase that amounted to 6.6%. General reaction was "too little too late."

Airlines felt the profit pinch early in 1957 before the overall traffic volume began to level off. American Airlines canceled an order for a fleet of DC-7D cargo planes because of the grim outlook for airlines in the loan market. Capital Airlines dropped its orders for 14 de Havilland turbojet Comets and an additional 15 turboprop Viscounts. Northeast decided to cancel its order for five Bristol turboprop Britannias when the May delivery date was postponed.

Some observers now fear the unexpected downward swing in the industry's historic growth pattern is a signal warning that traffic expansion has reached a temporary plateau. Others are attributing the slowdown to the current economic recession and an accompanying tightening of the travel dollar.

One bright spot concerning the future came in May when AVIATION WEEK revealed the first details of a comprehensive survey conducted by the Airborne Instrument Laboratory. This group predicted an increase in airline passenger-miles from 22.3 billion in 1956 to 66.7 billion in 1957. Number of passengers was expected to climb from 41 million in 1956 to more than 153 billion during the same year.

Competition on the major trunk routes increased substantially during

Comparative Direct Operating Costs

(Cents per U. S. domestic plane-mile, 6 months ending June 30)

	1957						1956			
	Flying Operations	Applied Direct Maintenance	Maintenance Burden	Depreciation Charges	Interchange Aircraft Expense	Total Direct Operating Costs	Flying Operations	Direct Maintenance	Depreciation Charges	Total Direct Operating Costs
DC-3	37.91	11.91	7.93	.74	.26	58.75	34.94	12.69	.74	48.37
CV-240	44.25	22.68	15.81	1.13	....	83.87	40.67	21.71	2.37	64.75
CV-340	44.21	17.20	11.58	17.23	.20	90.42	41.56	18.37	16.10	76.03
CV-440	44.40	16.52	10.21	45.14	....	116.27	.....	.....	.....	.....
M-202	47.65	22.21	13.65	21.00	....	104.51	44.16	23.57	21.01	88.74
M-404	47.05	20.15	9.96	4.83	.77	82.76	42.65	21.90	14.70	79.25
DC-4	56.77	26.44	14.42	1.73	....	99.36	50.44	24.79	1.70	76.93
DC-6	57.20	25.18	16.73	3.19	2.77	105.07	54.73	22.66	4.87	82.26
DC-6A	62.86	24.46	18.41	22.80	....	128.53	54.50	15.23	23.59	93.32
DC-6B	62.25	20.66	13.11	17.07	8.14	121.23	66.11	21.90	17.08	105.09
DC-7	65.07	30.47	18.41	28.07	2.71	144.73	62.06	31.54	25.75	119.35
DC-7B	67.87	29.01	12.35	51.43	....	160.66	66.99	26.42	53.93	147.34
DC-7C	64.48	23.05	11.32	27.02	....	125.87	.....	.....	.....	.....
L-049	81.59	28.01	14.54	10.57	....	134.71	59.08	36.60	8.82	104.50
L-749	65.92	27.24	13.78	10.23	....	117.17	61.72	29.11	7.99	98.82
L-1049	74.04	29.05	15.91	9.78	....	128.78	71.22	31.56	15.51	118.29
L-1049C	75.49	29.19	13.49	37.11	....	155.28	71.53	36.39	40.38	148.30
L-1049G	72.84	30.22	15.17	43.01	....	161.24	70.70	45.82	40.71	157.23
L-1049H	265.64	1.47	1.36	.....	....	268.47	.....	.....	.....	.....
L-1649A	75.53	21.61	6.05	54.42	....	157.61	.....	.....	.....	.....
VV-745	41.00	13.62	7.80	19.27	....	81.69	35.20	3.51	20.68	69.39
C-46	40.06	16.57	8.07	17.95	....	82.65	.....	.....	.....	.....
Lodestar	28.58	11.80	9.66	1.56	....	51.60	.....	.....	.....	.....
B-377	83.99	52.94	21.08	1.25	....	159.26	78.21	39.74	40.29	158.24

Note: Due to a change in Civil Aeronautics Board accounting practices, strict comparison between 1956 and 1957 data does not place a fair interpretation on these figures. However, data covering flying operations including interchange aircraft expense, direct maintenance and depreciation charges for the two years are comparable to a safe degree. Applied maintenance burden costs, formerly applied to ground and indirect maintenance, is a newly assigned item to direct operating costs.

the year as the result of a Board policy in 1954-55 designed to strengthen the so-called "regional" carriers by broadening competition in lucrative traffic markets. On the New York-Washington route, for example, nine airlines served this segment last year compared to three in 1955.

C. R. Smith, American's president, charged that the number of airlines on major routes has "thinned out" available traffic, cutting load factors and contributing to operating losses on marginal routes. United's president, W. A. Patterson, said the need for increased revenues through fare increases would be $10 million a year less had not the Board's philosophy of more competition been adopted.

Subsidy End

The fact remains, however, that the Board's action has helped remove the subsidy element from domestic trunkline activities. Last year, both Northeast and Continental airlines, the last two companies to operate on a subsidy basis, were placed on a service mail rate.

In general, the industry embarked on strict austerity programs to shave expenses.

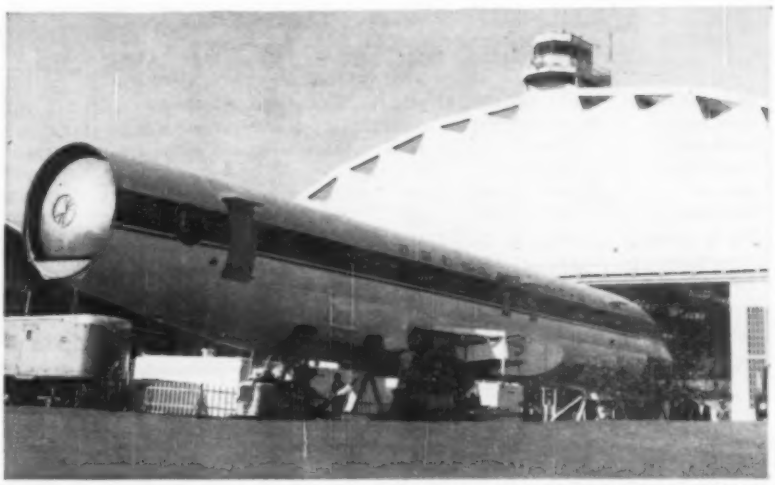
However, because of high fixed costs, economy moves had little effect on the rising expense level. Wide-scale personnel cutbacks were not possible and new demands by unions for higher wages and more fringe benefits presaged another hike in labor costs which already account for 46% of all operating expenses.

Pilot Pay Climbs

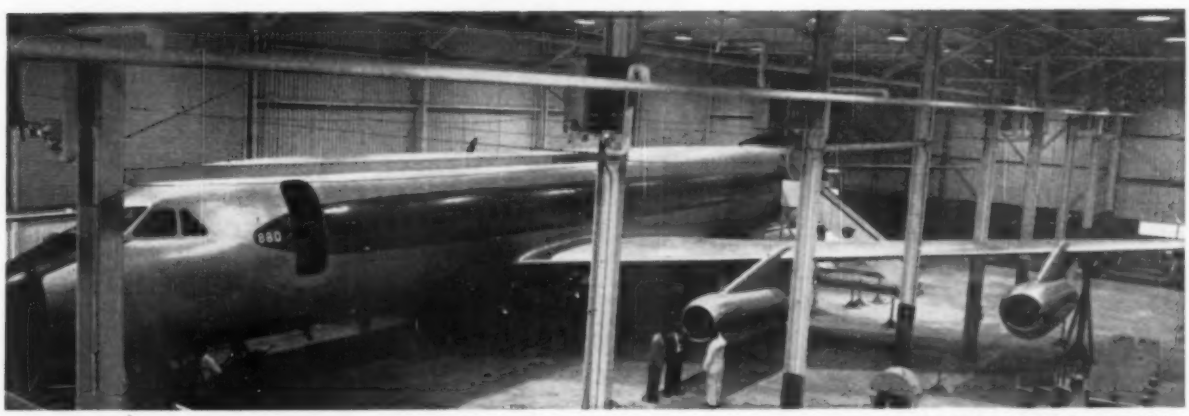
Pilot's and co-pilot's pay alone has climbed 50% since 1947 even in cases where no changes in flight equipment has been involved.

Air traffic control problems threatened to boost rising costs even higher. In a survey conducted by the Air Transport Assn., it was learned that, during the first five months of 1957,

PAN AM BOEING 707



DOUGLAS DC-8 PRODUCTION PHASE



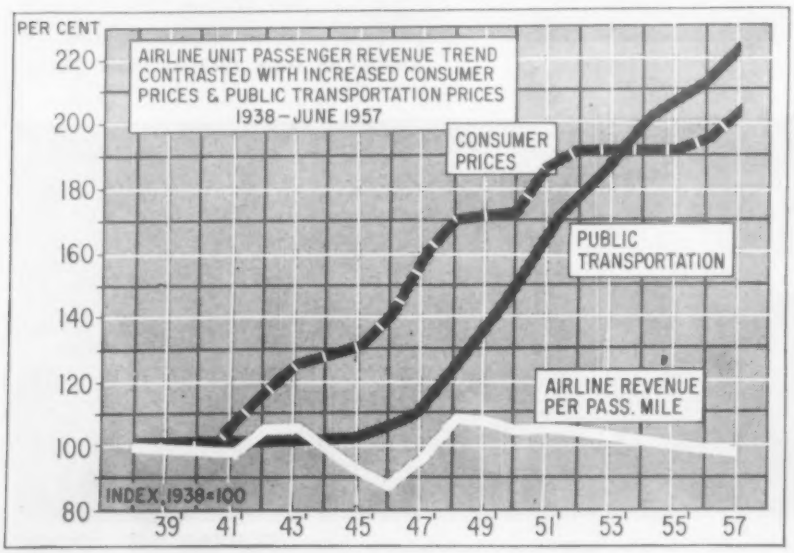
CONVAIR 880 MOCKUP

Domestic Trunklines—Estimated Traffic and Revenues 1956, 1957

	1957	1956	Percent Increase
TRAFFIC		(000 omitted)	
Revenue Passenger-Miles	24,716,465	21,643,141	14.2
Mail Ton-Miles	97,751	91,686	6.6
Express Ton-Miles	43,481	49,711	−12.5
Freight Ton-Miles	233,352	190,595	22.4
Revenue Ton-Miles	2,763,145	2,452,469	12.7
REVENUES		(000 omitted)	
Passenger	$1,298,684	$1,142,201	13.7
Mail	34,018	31,594	7.7
Express	15,175	18,102	−16.2
Freight	51,631	42,172	22.4
Other	32,751	26,153	25.2
Operating Revenues	1,432,259	1,260,222	13.7
Public Service	1,127	2,609	−56.8
Total Revenues	$1,433,386	$1,262,831	13.5

Subsidy Estimates, Fiscal Years 1952-1959

	1952	1953	1954	1955	1956	1957	1958	1959
				(000 omitted)				
Domestic Trunks	$6,411	$3,527	$3,880	$3,055	$1,863	$1,163	.....	.....
Local Service	18,990	21,800	24,300	22,637	24,907	27,087	$26,871	$32,030
Helicopters	.....	.....	2,574	2,656	2,784	3,817	4,067	4,115
Mail-Cargo	.....	.....	.....	.....	.....	.....	.....	.....
Alaskan	5,431	7,865	8,307	7,727	7,643	7,527	7,375	5,711
Hawaiian	715	871	689	293	290	285	283	.....
Trans Atlantic	5,837	4,182	1,625	203	611	873	.....	.....
Trans Pacific	11,641	12,173	6,461	.....	67	378	.....	.....
Latin American	14,511	16,223	16,135	8,204	6,425	7,045	5,880	781
Total	63,536	66,641	63,971	44,775	44,590	48,175	44,476	42,637



air traffic control delays totaled 3,241 even though only 2½% of all flights were checked. The delays added up to more than 423 hours.

Civil Aeronautics Administration held to its accelerated pace in implementing the airways with additional and improved facilities including range radar and vortac facilities but President Eisenhower's proposed budget for fiscal year 1959 fell short of CAA's requirements and posed a new threat to the federal airway program.

Airway Proposal

In May, Edward Curtis, special presidential aid on leave from the Eastman Kodak Co., introduced his recommended plan for a federal airway system.

After 18 months of study, Curtis called for an all-powerful Federal Aviation Agency which would absorb the CAA and take over all but the economic regulatory powers of the CAB. He asked for the elimination of the Air Coordinating Committee and recommended the end of the Air Navigation Development Board.

Curtis proposed the organization of an interim group to be known as the Airways Modernization Board to do research and development on an airways system prior to the establishment of the Federal Aviation Agency in 1960. The Board was set-up immediately thereafter and Elwood Quesada was named chairman and special assistant to the President.

Quesada took over the staff and facilities of the Air Navigation Development Board and announced his intention to let contracts to private industry to handle the research and development functions. The President has asked for a $35 million appropriation to cover the cost of operating the AMB.

Airlines vs Military

Civil Aeronautics Board acted to settle the bitter conflict between the military and the airlines over the allocation of airspace. The airlines have charged that the military has been wasteful in assigning restricted airspace areas for military purposes, causing a serious threat to the development of a high-altitude jet airways system for transport aircraft.

Last year, the Board issued a draft release proposing that the allocation of all airspace be assigned to the Administrator of Civil Aeronautics. Military agencies through the Defense Department protested the Board's action on both legal and national defense grounds.

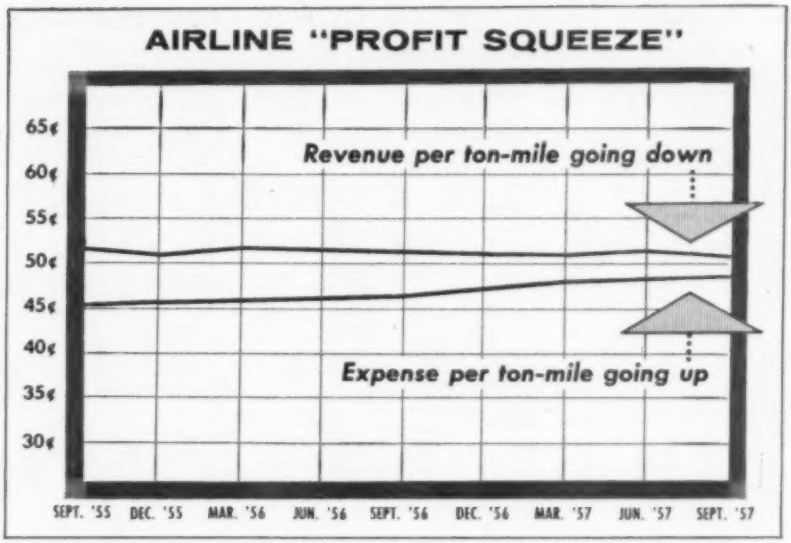
However, it now appears the Board will have its way in handling airspace assignment through the CAA.

In another move to accelerate the flow of high-speed traffic, CAA issued

Load Factors

Average Passenger Load Factors of the 12 Certificated Schedule Trunk Airlines for 1957 as Compared with 1956.

AIRLINE	1956 (actual)	1957 (est)
American	68.5	65.1
Braniff	60.7	58.6
Capital	60.2	59
Continental	54.3	54.1
Delta	60.1	59.2
Eastern	60.7	59.5
National	65.9	59.7
Northeast	58.5	47.9
Northwest	61.2	57.3
Trans World	64.3	63.1
United	67	64.4
Western	61.9	60.6



orders calling for IFR—instrument flight rules—on all flights operating over 24,000 ft. Air Line Pilots Assn. applied similar rulings to flights operating over "golden triangle" routes between Chicago, New York, Washington and Chicago at 9,500 ft. or above.

Internal Woes

Management shake-ups in three of the 12 trunkline carriers attracted public attention to the industry's internal woes. In July, USAF Maj. Gen. David Baker was named president of Capital Airlines and former president, J. H. Carmichael, was elevated to Chairman of the Board.

In December, Capital's vice president of traffic and sales, James W. Austin, was named president of Northeast Airlines with former president George Gardiner moving up to Chairman of the Board and Chief Executive. Six of Capital's top sales executives transferred to Northeast with Austin. Northeast inaugurated its newly awarded New York-Miami route in January.

Trans World Airlines president Carter Burgess resigned in December because of a disagreement over policy matters with Howard Hughes, sole owner of Hughes Tool Co. which holds a 77.6% interest in TWA. Chairman of the Board, Warren Lee Pierson, has been named acting president of the airline.

No-Show Plan

Carriers forestalled another Civil Aeronautics Board investigation by introducing a three-point no-show plan which included for the first time a penalty charge of $3 on passengers who fail to show for a flight without canceling the reservation.

The ruling also requires passengers to reconfirm space on roundtrip passage to pickup tickets within an established minimum time limit. Airlines report a significant decline in the number of no-shows as a result of the plan.

Carriers also challenged the Board's "realistic scheduling" regulation which makes it a criminal offense to fail to operate flights within 15 minutes of published time schedules 75% of the time.

Airlines labeled the ruling, which became effective in September, "unworkable and vague" and warned the Board that "loose" scheduling practices may result.

Depreciation Trouble

Depreciation of engine and airframe programs delineated by the Board also drew fire from the airlines. Carriers say that depreciation practices are a definite function of management and cannot be regulated.

Straight-line methods and a seven-year life with a 15% residual value required by the Board is not flexible enough to meet the varying needs of the individual carriers, they say. Air Transport Assn. is appealing the Board ruling in the Circuit Court of Appeals.

Forecasts for 1958 indicate trunklines will experience an 8-10% increase over 1957. However, a prolonged tight travel market, a natural reaction to a soft economy, could force load factors down to a substantial degree.

If available seat-miles continue to rise at the high 18% rate pattern set in 1957, load factors will be hit even harder unless equipment retirement programs are launched by some carriers earlier than is now planned. At least more than 150 new aircraft will be added to trunkline fleets this year.

However, it is apparent that the air lines are continuing to attract new customers. Hardest hit in the dwindling travel market have been the railroads and bus lines which experienced a steady traffic decline throughout the year.

Domestic Gain

Despite the economic setback and two highly publicized accidents during the first of the year, domestic trunklines recorded a 12.6% gain in revenue ton-miles in 1957 compared to 1958.

Constant improvement in on-time service and a continuance of a safety record that last year was the second best in airline history will help repeat that gain in 1958 despite depressing factors that threaten normal airline growth.

Total Traffic on U. S. Common Carriers

	1957 (EST.)		1956 (ACTUAL)	
	Passenger-Miles (millions)	Percent of Total	Passenger-Miles (millions)	Percent of Total
Air	25,476	40.3	22,276	35.9
Rail	21,714	34.4	23,380	37.7
Bus	16,023	25.3	16,409	26.4
Total	63,213	100.0	62,065	100.0

U. S. Aircraft Engaged in Air Transportation

SCHEDULED AIR CARRIER, DOMESTIC SERVICE

Cert. No.	OPERATOR	Douglas						Vis-count	Lockheed				Martin		Boeing	Convair			Curtiss	Grum-man	Helicopters				Total
		DC-7	DC-6	DC-6A	DC-6B	DC-4	DC-3	744	1049	749	049	1649	404	202	377	440	340	240	C-46	G-21	S-51	S-55	S-58	47G	
165	Allegheny Airlines						15							7											22
25	American Airlines	58	50	10	25													63							206
604	Bonanza Air Lines						9																		9
18	Braniff Airways	†7	9				23									5	25								69
21	Capital Airlines					12	18	59			12														101
404	Central Airlines						13																		13
14	Continental Airlines	4					15									3	6								28
26	Delta Air Lines	17	7				15				4		5			8	18								69
10	Eastern Air Lines	‡28			5	12			*38	18			58			20									185
501	Frontier Airlines						15																		15
306	Lake Central Airlines						10																		10
104	Mohawk Airlines						11											11							22
16	National Airlines	7	4		6											6	12								37
303	North Central Airlines						27																		27
15	Northeast Airlines				10		11											6							27
20	Northwest Airlines	8			17	15	5								9										54
308	Ozark Air Lines						20																		20
208	Piedmont Airlines						21																		21
209	Southern Airways						13																		13
601	Southwest Airways						15							7											22
401	Trans-Texas Airways						20																		20
17	TWA. (Domestic)					8			39	38	32	24	37	11											190
11	United Air Lines	47	42	5	38	2											55								189
702	West Coast Airlines						14																		14
28	Western Airlines				14		5											9							28
	HELICOPTERS																								
304	Chicago Helicopter Airways																					3	3	6	12
803	Los Angeles Airways																				2	5			7
107	New York Airways																					4	3	1	8
	*CARGO ONLY"																								
213	Aerovias Sud Americana																		4						4
605	Flying Tiger Line			2		6			12																20
212	Riddle Airlines			1		2													29						32
606	Slick Airways, Inc.			7		6																			13
1-502	Seaboard Western					4			15																19
	TERRITORIAL AND ALASKAN AIRLINES																								
902	Alaska Airlines			1		3	1												2						7
804	Alaska Coastal Airl.																			9					9
806	Cordova Airlines						2												1						3
805	Ellis Airlines																			9					9
5	Hawaiian Airlines						8										5								13
803	Northern Cons. Airlines						4																		4
801	Pacific Northern Airlines					2	4			3															9
807	Reeve Aleutian Airways					1	2																		3
901	Trans Pacific Airlines						7																		7
506	Wein Alaska Airlines						3																		3
	INTERNATIONAL SERVICE																								
32	Caribbean Atl. Airl.						4																		4
1001F	Mackey Air Transport					2	2																		4
8	Panagra	†4	5		5	2	4																		20
1	PAWA-AD	†16			30	8									8										62
4&6	PAWA-LAD	‡8	28			12	2											1							51
2&3	PAWA-PAD	†16				5									16										37
211	Resort Air Lines					8																			8
	Total: All Domestic and International Aircraft	220	145	26	152	110	330	59	104	60	54	24	95	25	33	42	121	90	36	18	2	12	6	7	1,779

* Includes 1049C, 1049G, 1049H †DC-7C ‡DC-7B

NEW YORK International Airport serves airlines from nearly every nation. Aerial photo shows new terminal facilities.

Flag Lines Compete for Record Traffic

By Glenn Garrison

New York—Busy hauling record numbers of passengers, with expanded fleets and routes, against a background of rising costs and stiffer competition, the U. S. flag airlines found little breathing space in their next to last year before the jet age.

Despite economic uncertainties here and abroad, the increase of overseas vacationers and other tourist class travelers continued during 1957, though somewhat more slowly. More and more Americans were leaving the country for their holidays, and more of them were going by air.

Business on the North Atlantic, lushest served by the U. S. international carriers, started shakily early in the year but recovered and went on to new highs. Routes to the Caribbean, South America, and across the Pacific reflected the increasing popularity of other parts of the world than Europe for the U. S. tourist.

Total sea and air travel to foreign countries from the U. S. during the year ended June 30, 1957 was 1,976,715, an increase of 9% over the previous year. But the corresponding 1956 increase was 15%. Arrivals during the year ended June 30, 1957 totaled 2,338,768, up 12.9% from the previous like period, compared with a 1956 increase of 13%.

Air travel continued to forge ahead of sea travel at an increasing pace. The airlines during the above period carried more people to Europe than went by sea, the second year of such leadership. While sea travel from the U. S. has remained fairly constant during the past five years, air travel to foreign countries has increased 74%.

Southbound Increase

South America emerged as one of the fastest-growing attractions for U. S. travelers. During the year ended June 30, some 61,067 American citizens departed for that continent, compared to 49,215 in 1956. Most of the 1957 passengers—51,228 of them—went by air.

U. S. flag carriers, however, are gradually being outdistanced by the heavy competition in terms of percentage increases in traffic. During the year ended June 30, foreign flag airlines carried 26.5% of all international passengers to and from the U. S., up from 22.6% the previous year. The American carriers' share dropped from 45.4% to 44.3% of the total.

Bitter Dispute

Last year was one of intensified dispute, some of it bitter, as to the traffic rights that foreign carriers should enjoy in the U. S. Several new points were opened up to the foreign competition. The State Department was criticized on the one hand as too generous to foreign demands for rights, and on the other hand failed to satisfy some of the most clamorous demands.

At the same time, a bilateral agreement with Mexico, 10 years in the making, finally was signed and new routes between that country and the U. S. were opened up.

North Atlantic carriers, after ex-

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tended hassling in the International Air Transport Association, agreed late in the year to take the plunge and implement a third class, low "economy" fare. The new service, restricted by agreement to relative austerity, will be offered beginning April 1.

North Atlantic High

The IATA carriers broke the million mark on the North Atlantic for the first time last year with a total of 1,022,000 passengers carried, including 53,823 charter passengers. Pan American World Airways and Trans World Airlines hauled almost half of the total scheduled traffic, with about 28% going to Pan Am and 15% to TWA.

Eastbound transatlantic traffic was under expectations for the first few months of the year, probably because the Suez crisis of late 1956 caused many travelers to delay plans. But the traffic picked up sharply in April; resulted in a record peak season which extended a month longer than usual.

West bound traffic, boosted by low immigrant fares, was extremely high during most of the year and accounted for the greatest part of the increase over 1956.

During the year the Atlantic carriers sought a 5% fare increase to help them offset rising costs of operation. CAB, however, was firmly opposed to the move and it was dropped amid bitter comment from IATA members obviously aimed at the American agency.

Trans World put its new Lockheed 1649A "Jetstream" Constellations on the Atlantic last year, while Pan American continued using the DC-7C.

Both carriers began service last fall on the polar route from the West Coast to Europe, joining battle with Scandinavian Airlines System for traffic on the route. Pan Am's first flight to Paris was jeopardized by trouble with the French government, seeking new bilateral terms with the U. S. including a polar route for Air France. The American carriers were permitted to begin service but the question is still under U. S.-French negotiation.

Round-the-World

TWA and Northwest Orient Airlines on Jan. 1, 1958, began their joint round-the-world service connecting at Manila.

Trans World's Super Gs depart eastward from New York on a route extended from Colombo, Ceylon, to the new Manila terminal, while Northwest DC-7Cs fly west from New York.

Trans World also has closed up its European routes with a link from Frankfurt to Zurich. The carrier last year began new transatlantic nonstop services to Frankfurt, Rome and Zurich.

Pan American and Northwest continued their battle in the on-again, off-again Trans-Pacific Renewal Case. Civil Aeronautics Board followed its examiner's recommendation and recommended to President Eisenhower that Pan American be authorized to fly a direct Great Circle route between California and the Far East, but denied the authority to operate Portland-Seattle-Tokyo route in competition with Northwest. The President approved the recommendation in August, but in September reversed himself and asked to hold the decision in abeyance.

Northwest has received permanent certificates to operate the Pacific route and the inside route to Alaska. The airline put DC-7C equipment on the Pacific last year.

Pan American's Pacific-Alaska Division recorded gains in 1957. On the route between the West Coast terminals and Hawaii, traffic rose 20% to 142,400 passengers.

The total for Pan American's Central Pacific routes was 96,150 passengers, a 9% increase. In the South Pacific, Pan American traffic was up 10% to 17,930 passengers.

The airline's Latin American Division handled 1,336,000 passengers last year, up from 1,126,828 in 1956.

United Air Lines handled 102,008 passengers last year in its Hawaiian

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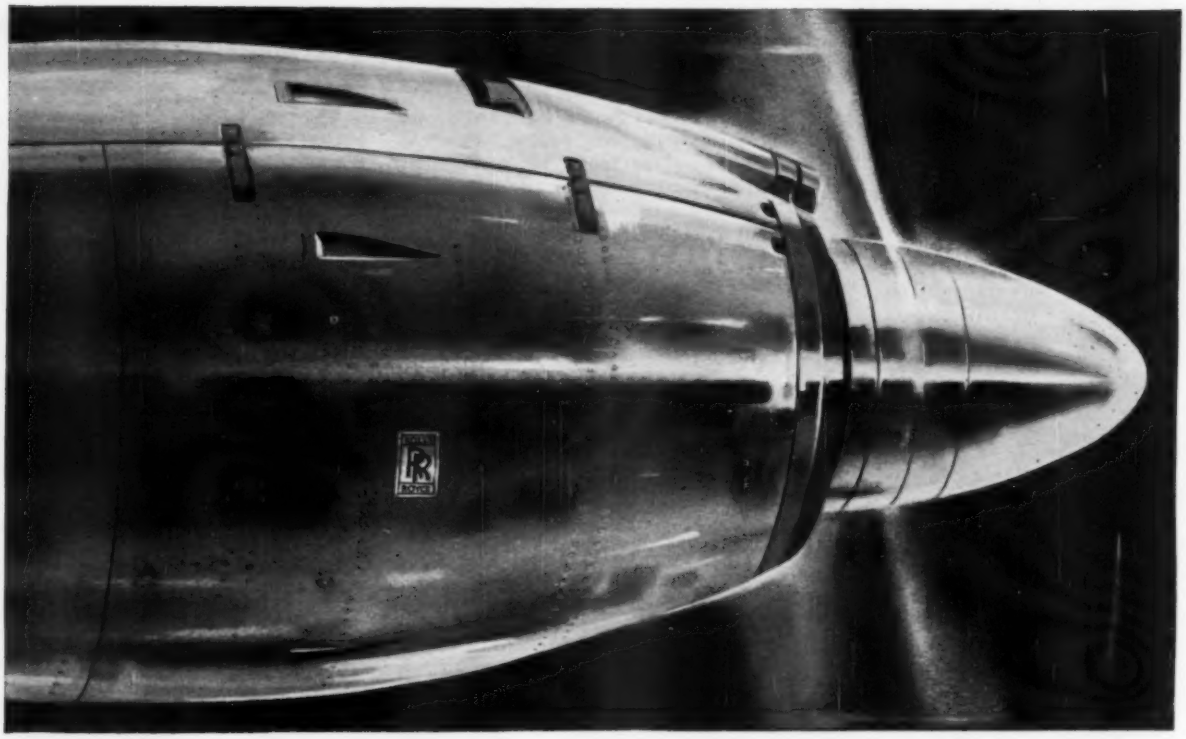

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operation, a 4.6% increase over 1956.

A highlight of 1957 was the provisional bilateral agreement signed last March between the U. S. and Mexico. Seven routes were authorized under the agreement until June, 1959.

Mexican Agreement

As a result of the agreement and of CAB decisions following it, American Airlines is now operating nonstop between Mexico City and Chicago, Eastern Air Lines is flying nonstop to New Orleans and New York from Mexico City, and Western Air Lines flies Los Angeles-Mexico City nonstop.

Western, now operating a daily flight in each direction, is averaging 55-65% load factors with its first class DC-6Bs but feels additional frequency will be needed to make money on the run. The airline, competing against Mexicana DC-7Cs, hopes to add a tourist flight when loads reach a point where a second daily flight may be applied for.

Eastern, flying first class DC-7Bs, went into Mexico City from New Orleans on July 23 and from New York on Sept. 20. Traffic through December totaled 16,468 passengers on both routes.

American, which has operated between Chicago and Mexico City for some years with stops at Fort Worth or Dallas, began its nonstop DC-7 service Jan. 5, and will battle Mexicana for tourist and first class business.

Pan American, after fighting for the New York-Mexico City run, not only lost out to Eastern but must divest itself of stock in Aeronaves de Mexico.

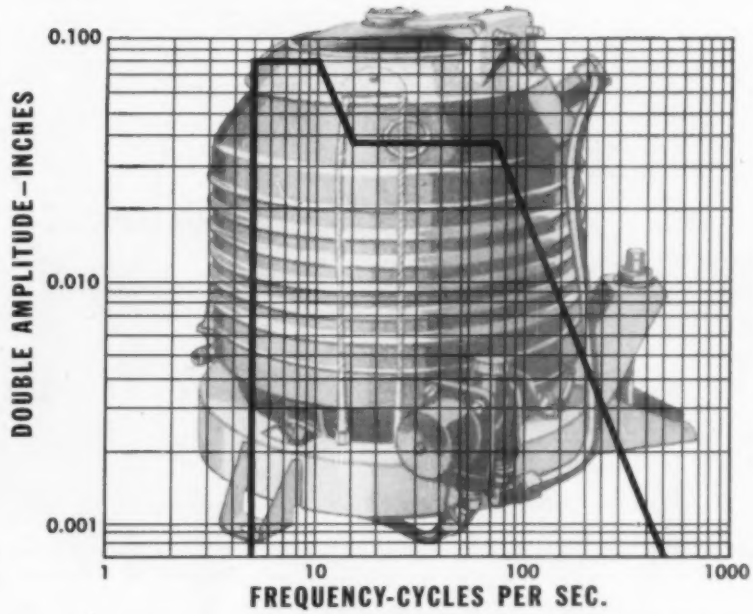
Latin America

Braniff International Airways last year increased its available seat miles in Latin American service by 21% and flew 33% more revenue passenger miles on its international routes. The airline inaugurated DC-7C on its international system and services between the U. S. and Bogota, Colombia, during the year. Through interchange with Eastern, Braniff operates DC-7 schedules from New York and Washington to Panama, Peru and Brazil through Miami.

Braniff is offering its biggest tour program to Latin America this year, with more than 50 packages, and has employed a staff of commissary and passenger service managers in various Latin American cities.

Delta Air Lines describes the Caribbean area as the fastest-growing in the world for tourist activity, predicting 1.5 million visitors in 1960.

The airline's traffic from New Orleans to the Caribbean last year totaled more than 20,000 passengers, a 26% increase over 1956.



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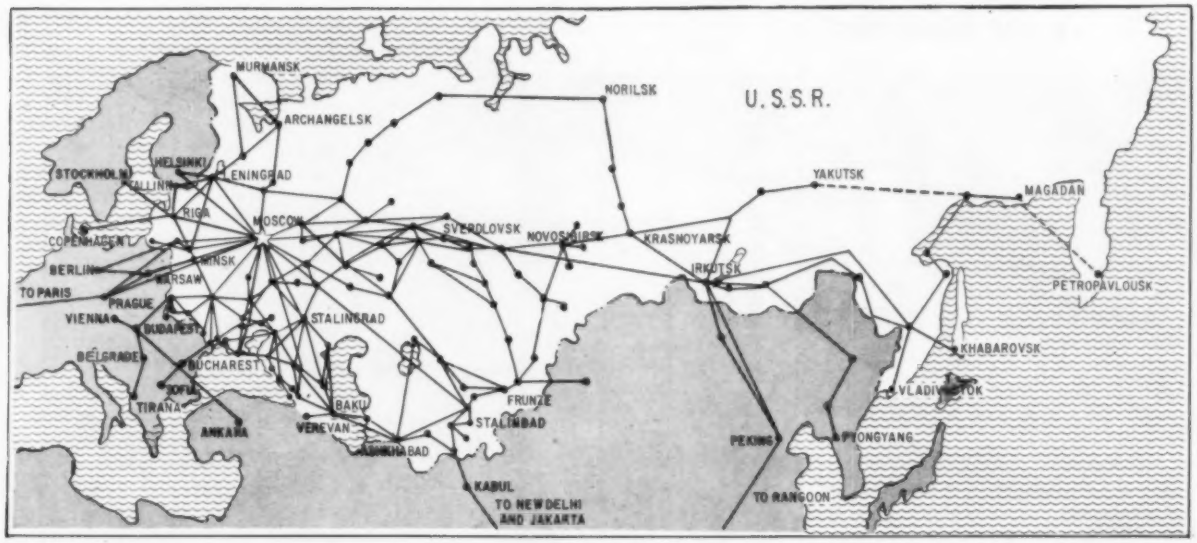


AEROFLOT'S main domestic and foreign routes, together with proposed extensions, are shown on this official map. A direct trans-Siberian service from Moscow to Petropavlovsk on the Kamchatka Peninsula via Novosibirsk, Yakutsk and Magadan is scheduled to start soon.

Aeroflot Expansion Sparks Upswing

Moscow—Russia's Aeroflot wore its title of world's largest airline with increasing distinction during 1957.

Backed by Communist prestige economics which show little concern over red ink, the Soviet carrier expanded and upgraded its service, unveiled a whole family of new turbojet and turboprop transports, and made a good start on its broad program for improving ground facilities. Meanwhile, the USSR's first 500 mph. commercial transport, the twin-jet Tu-104, completed a full year of scheduled operations.

With the highly-publicized Tu-104s replacing piston-engine Il-12s and Il-14s on Russia's major long-haul domestic and international routes, Aeroflot showed the largest traffic gains in its 35-year history. During the first nine months of 1957, the line boarded 69% more passengers than in the same 1956 period.

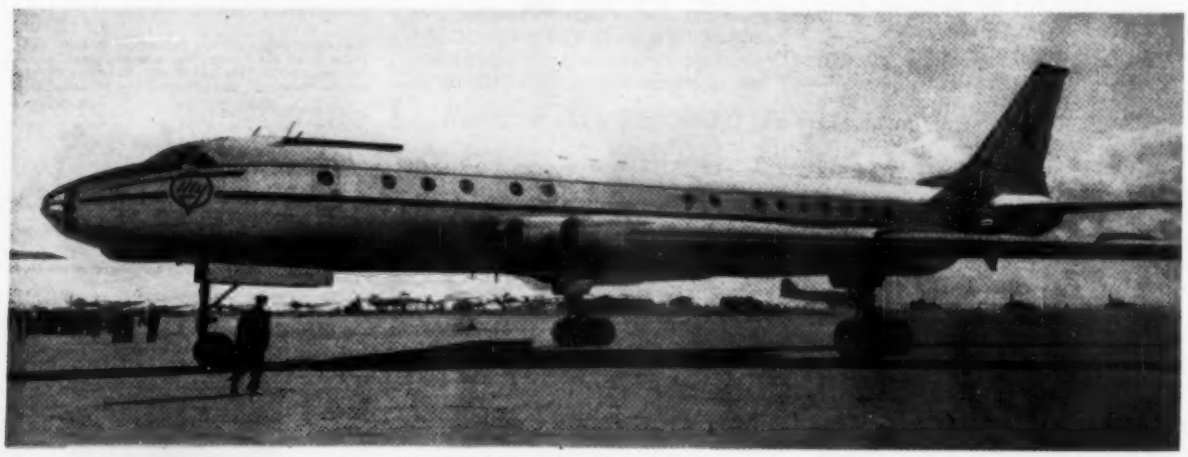
The soaring traffic figures indicate that Russia's ambitious goals for commercial aviation under the Sixth Five-Year Plan are likely to be fulfilled. They call for quadrupling passenger business between 1955 and 1960.

Until last year, Aeroflot's rate of growth was modest, lagging well behind that of major U.S. and other Western carriers throughout the postwar period. But from now until 1960, at least, the situation will probably be reversed.

According to Chief Air Marshal Pavel Zhigarev, Aeroflot's director, two new four-turboprop transports—the Ilyushin Il-18 "Moskva" and the Antonov "Ukraina"— are to go into regular service this year.

The Moskva, which is being built in 75- and 100-passenger versions, has a cruising speed of 404 mph. and a maximum range of over 3,100 miles. Specially designed for short fields, it can take off fully loaded in less than 2,500 ft. and land in under 2,000 ft. When introduced, it was billed as having the lowest ton-mile cost of any transport plane in the world.

The Ukraina is slightly smaller than the Moskva. It has a normal takeoff weight of 51 metric tons (112,435 lb.)



FLIGHT tests are under way on Aeroflot's Tu-110, a four-jet version of the Tu-104.

TUPOLEV Tu-114

against 58 metric tons (127,867 lb.) for the Il-18, and a payload of 13 metric tons (28,652 lb.) against 14 metric tons (30,856 lb.) for the "Moskva."

Seating from 84 to 126 passengers, the "Ukraina" cruises at 373-404 mph. Like the Moskva, the Ukraina is designed to operate into Aeroflot's existing airfields and can operate from dirt or grass runways.

Other new Aeroflot transports undergoing flight tests are the four-jet Tu-110 and four-turboprop Tu-114 Rossiva.

The Tu-100 accommodates 100 passengers, cruises at 497 mph., and has a maximum speed of 621 mph. Practical range with a 12 metric ton (26,455 lb.) payload is 1,925-2,050 miles.

Aeroflot's Scientific-Research Institute believes that ton-mile costs for the Tu-110 will approach those of the new Soviet turboprop planes.

The double-decked Tu-114, said to have a top speed of 600 mph., will be employed in three versions. The 120-passenger "intercontinental" model reportedly will be able to fly nonstop from Moscow to New York in 10-12 hours or to Vladivostok, Peiping, Delhi, Tokyo or Rangoon. The shorter-range tourist version will carry 220 passengers, the standard version 170.

New Russian turbojets and turboprops will also give a big boost to Aeroflot's freight business, which is slated to double under the Sixth Five-Year Plan. The Tu-114 "Rossiva" turboprop, for example, can handle up to 16 metric tons (over 35,000 lb.) of cargo in its two lower deck holds.

Even with a 100-passenger load, the

UKRAINA An-10

MOSKVA Il-18

four-jet Tu-110 can take on about 9,000 lb. of cargo, mail and baggage. A special airfreighter version of the "Moskva" is to be built.

The military implications of these figures are obvious. But the Soviet press never mentions the fact that Russia's new commercial planes also have a tremendous potential for carrying troops and war materiel.

Aeroflot admits that its 50-passenger Tu-104s are expensive to operate and that their monthly utilization has been low. But it points out that the planes have been invaluable as trailblazers for the more efficient turbojets and turboprops that are to follow.

Air Marshal Zhigarev claims that flight and ground crews are already so well trained that the punctuality of Tu-104s has become a by-word. He says that "service personnel at the Prague international airport set their watches by Tu-104s' arrivals and departures."

Besides their scheduled operations, Aeroflot Tu-104s have taken over almost exclusively the special task of flying distinguished foreign visitors to and from Moscow. If a chief of state or other dignitary arrives in the Russian capital by Tu-104, the type plane is invariably cited in Soviet newspaper reports. But if the guest comes by a piston-engine Aeroflot plane, the craft is not mentioned.

Aeroflot officials emphasize that as more jets become available, they may be assigned to medium- as well as long-haul routes. The Russians say that Tu-104s, Tu-104As and Tu-110s "can, from the standpoint of ton-mile costs, be employed successfully on stages ranging downward to 620 miles."

Nevertheless, Aeroflot's piston-engine Il-12s and Il-14s aren't going to disappear from Soviet airlanes overnight. The USSR's Sixth Five-Year Plan provides for use of the 24-passenger Il-14s with their 200 mph. cruising speed as "the principal type of medium-capacity, twin-engine transport through 1960."

In contrast to the large turboprops and turbojets, designer Antonov has developed the seven-passenger Pchelka (Little Bee) light transport for use on Aeroflot's growing network of local routes. Boasting a top speed of around 125 mph., the Pchelka is said to be capable of operating from "any small field, roadway or level spot 45 to 65 yards long."

New Routes

Aeroflot's swift advance into the international "big time" will continue during 1958. Now making regularly-scheduled flights to 16 foreign countries, the carrier has well-developed plans for extending its operations to such points as London, Paris, Delhi and Amsterdam. In all cases, it expects to provide faster service over the routes than any of its capitalist competitors.

Domestically, Aeroflot is slated to begin regular Tu-104 service from Moscow to Petropavlovsk, Kamchatka, "shortly." The Soviet jets are to cover this 5,590-mile air route (Russia's longest) in 10 hours 36 minutes flying time.

Other new Aeroflot jet routes in 1958 will include Leningrad-Vladivostok, Moscow-Magadan (in the Far East) and Moscow-Norilsk (in far-northern Siberia).

Frequency of existing Tu-104 services will be stepped up shortly.

Plans also call for inauguration of scheduled passenger helicopter service in the Crimea and other areas.

Meanwhile, Aeroflot's airport and terminal improvement program, which began to show solid results last year, will be allotted a 50% increase in funds during 1958.

One of the most significant of Aeroflot's new policies is its professed intention to continue lowering its sky-high fares. This traffic-generating move, already made on many Russian routes, is in line with the USSR State Planning Committee's decision that Aeroflot's goal must be to reduce fares, even on new jet and turboprop aircraft, to a level "no higher than hard-seat railroad coach tariffs."

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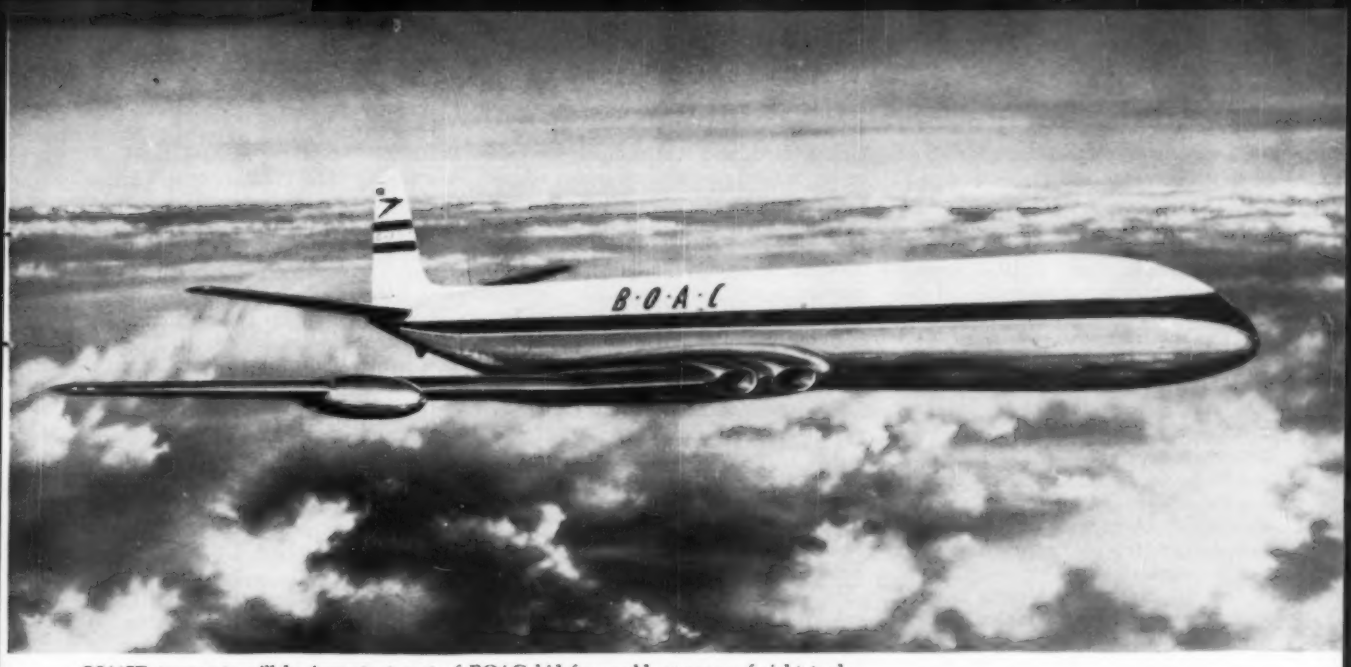

COMET transports will be important part of BOAC bid for world passenger, freight trade.

Competition Stimulates World Traffic

Airline traffic continued its growth in most areas of the world during 1957 and carriers of various nations stepped up their competitive pace in battling for the business.

Route expansions took place over most major airline networks and the carriers added new, modern piston planes to their fleets and went ahead with orders and plans for the jet age.

Increased tempo of competition added sharpness to the continuing disputes over traffic rights, particularly in the United States. Bilateral negotiations over rights were a prominent feature of the year's activity among the world's airlines.

Argentina

Favorable effects of the reshuffle of Argentine aviation in 1956 after the fall of the Peron government continued to be felt last year. Two new airlines were added to the four which previously had resulted from the abolition of a commercial aviation monopoly by the state.

The new, privately-owned carriers are Austral Cia Argentina de Trasportes Aereos, which has just begun internal service with C-46 equipment; and Aerolineas INI Cia S.A., which plans to operate DC-4s or DC-6s between Buenos Aires and Miami and Buenos Aires and Caracas.

Transcontinental S. A. progressed furthest during 1957 of the four lines established in 1956. The carrier plans to begin international service in April, serving New York with Lockheed 1049 H Constellations via Sao Paulo, Rio de Janeiro and Caracas.

Later in 1958, Transcontinental expects to operate to Tokyo via Sao Paulo, Lima, Mexico and San Francisco. The airline has ordered four Convair 880 jets for 1961 delivery.

State-owned Aerolineas Argentinas carried 461,245 passengers last year and flew 289,451,051 passenger-miles. Financial results for 1957 have not been revealed, but the Argentine national budget provides $13.5 million to cover the carrier's 1957 operating deficit.

Australia

Important changes in main Australian air services took place in 1957 and the carriers extended their routes and ordered new equipment.

A major development was the acquisition of Australian National Airways by Ansett Airways.

The new airline, called Ansett-ANA, has already embarked on a re-equipment program. Orders have been placed for four Lockheed Electras with the first two to be delivered at the end of 1958 and the final two in mid-1959. Four Vickers Viscounts 800 Series also have been ordered with delivery scheduled between October 1958 and January 1959.

Ansett-ANA has a majority shareholding in Butler Air Transport and is currently seeking to obtain control of Butler. If successful, it will transfer two of Butler's 700 Series Viscounts to Ansett-ANA and its Convair 440 Metropolitans will progressively replace DC-3s, DC-4s, DC-6s and DC-6Bs which will be sold to foreign buyers.

Trans-Australia Airlines plans to modernize its Viscounts to the 800 Series standard. It has placed orders for Fokker Friendships and is considering the purchase of either Caravelles or Electras for its trans-Australia route. At the same time TAA has started looking for a likely replacement for its Viscounts, something that could prove to be a success in the early 1960s.

Qantas last year began round-the-world service, calling at New York and San Francisco in the U. S. It has Boeing 707s on order and will be the first non-American carrier to obtain this new plane. Additional planes will be needed and Qantas' decision should be announced in the first part of 1958. One factor likely to affect it is the willingness of a supplier to assist in disposing of Qantas' fleet of Super Constellations at attractive prices.

Early 1958 also should see a decision on aircraft replacement by TEAL, now flying some of the first DC-6s ever produced. Vanguard and Electra are both in running and possibly other aircraft. If no other foreign airline is allowed to operate between New Zealand and Australia, it is possible that TEAL will settle on Super Constellations to be purchased from Qantas.

Belgium

Addition of new aircraft to its fleet and expansion of its routes helped Sabena Belgian World Airlines to increase its passenger traffic 30% last year to the 700,000 mark.

New equipment included 12 Convair 440 Metropolitans, which went into the carrier's European services. Eight new Sikorsky S-58 helicopters were delivered and made possible the opening in

March of a rotorcraft service between Brussels and Paris. Douglas DC-7Cs took over many of Sabena's long-haul runs to New York and to South Africa.

Brazil

Best airline year in this country's history was experienced in 1957, according to estimates based on results of the first three quarters. Net operating profits for the industry rose from $1.5 million to $2.6 million, overall passenger load factor went up from 51.4% to 53.6%, new equipment was received and ordered, and plans were made for new route expansions.

The profit figures, however, do not include subsidy, which in 1957 totaled about $5 million for Brazil's local airlines and are expected to reach the $11 million mark this year.

The three domestic airlines showed particularly good results for 1957, with two of them—Cruzeiro do Sul and Viaco Aerea—recording sizable profits after a money-losing 1956. The third, Loide Aereo, was in the black both years, increased its profit in 1957.

Latin America's biggest airline, Real Aerovias Nacional—present fleet more than 200 planes—is expected to operate an important new route this year linking Rio de Janeiro, Sao Paulo and Buenos Aires with Tokyo. Stops are planned at Bogota, Mexico City, Los Angeles, Honolulu and Wake Island (fueling only).

The Los Angeles rights have not yet been formally granted, but Brazilian officials expect no difficulty.

Real will receive four Super H Constellations this year and plans to put these planes on the Tokyo run and possibly in service to Chicago and Miami now flown by DC-4s. The airline has ordered three Convair 880s for 1959-60 delivery. Real's operating revenues in 1957 totaled $28.6 million, up from $20 million in 1956.

Varig, one of Brazil's big three overseas carriers, received two Super G Constellations last year and expected a third early this year, bringing its total of these aircraft to five. The airline may step up its New York-Brazil service from three to five weekly flights with the Super Gs. Varig's operating revenues for 1957 totaled $18.6 million, up from $14.3 million.

Varig has ordered two Caravelles for delivery in late 1958 or early 1959, thereby may be first in South America with turbojet equipment. The airline also has ordered three Boeing 707s for 1960 delivery.

Panair do Brazil, 49% owned by Pan American, added four DC-7Cs last year.

Canada

Chances that government-owned Trans-Canada Air Lines may lose its monopoly in transcontinental routes brightened considerably early this year when Canadian Transport Minister George Hees said that competition will be introduced on domestic routes where economic conditions warrant.

Canadian Pacific Airlines late last year applied for routes linking cities between Vancouver and Montreal to provide a new mainline route pattern of a competitive nature. No action has been taken on the application and Hees' statement was the first enunciation of government policy.

Previous policy has been under review by the Ministry.

The Conservative government which came into power last June has been expected to favor competition. However, an election has been scheduled March 31 and specific action may not develop until after that date.

In the meantime, Canadian Pacific last May inaugurated a new route, granted by the former Liberal government, to Lisbon from Toronto via Montreal. In September CPA extended this route to Madrid. The airline uses DC-6Bs on its international routes.

The service connects at Mexico City with the airline's route to Mexico and South America.

Service to Santiago, Chile, was added during the year to the South American run, which also serves Lima, Peru and Buenos Aires.

Another Canadian airline, Pacific Western, also has asked for a route between Vancouver and Windsor. The carrier would like to fly on to the Caribbean from Windsor.

Trans-Canada Air Lines last year carried 2,375,000 passengers, up from 2,100,000 in 1956. Revenue passenger-miles flown increased 16% to 1.38 billion, freight ton-miles were up 10% to 13,160,000, express and mail ton-miles totaled 2,610,000 and 10,000,000 respectively.

France

As 1957 ended a fair year for French air carriers, main topic in the industry was not so much traffic as the expected denunciation by France of its 1946 bilateral agreement with the U.S.

Officials of state-owned Air France, as well as those of the two main private lines, Transports Aeriens Intercontinentaux (TAI) and Union Aeromaritime de Transport (UAT), all predict their government will scrap the bilateral unless the U.S. accepts the principle that the French should have the right to fly to every U.S. city, or at least "getaway," from which U.S. flag carriers fly to France.

An important step in Air France's expansion program will take place April 1 with the inauguration of a Paris-Tokyo Polar route. Using newly-delivered Lockheed 1649A "Super Starliners," the carrier plans to link Paris with Tokyo in 30 hours with a fueling stop at Anchorage. Air France presently serves Tokyo via Middle East and southern Asia points. The Polar route will mean a time saving of some 35%. First Air France proving flight over the Polar route was made late in January. The Anchorage fueling stop requires no negotiation between the U.S. and France.

Another expansion of the Air France network, scheduled for March 15, will be a weekly Paris-Lima flight. At present the route terminates at Bogota. It will be extended to Quito, Equador, and terminate at Lima. The French carrier also expects to step up during 1958 its current service to Brazil and Venezuela. On its South American routes, Air France is working closely with the German line, Lufthansa.

Air France talks with Aeroflot and the Soviet government over direct Paris-Moscow operating rights were on an on-again-off-again basis throughout most of 1957. The Russians did permit the French line to set up a permanent Moscow representative. Air France would like to beat U.S. flag carriers into Moscow, but it isn't anxious to start the service in the near future. At present, Air France is serving 222 points in 76 countries.

During 1957, preliminary figures show Air France hauled 75,000 passengers across the North Atlantic as compared with 58,000 in 1956. North Atlantic load factor was 71% compared with a system-wide load factor of 67%.

Ton-miles during 1957 were up 8%, passenger-miles 11%. Freight ton-miles showed an increase of 6% while mail ton-miles increased 8%.

At the end of 1957, Air France's fleet consisted of 131 aircraft including eight 1649 Constellations, 22 1049 Constellations, 16 749 Constellations, 11 Viscounts, 12 Breguet Provences, 23 DC-4s and 39 DC-3s.

During 1958 Air France will take delivery of two 1649A Constellations, the last of its piston aircraft on order. Toward the end of '58, the line expects to take delivery of the first two of its 12 Caravelle jetliners on order. Air France officials haven't as yet decided where the Caravelle will first go into service. Two routes most likely for early 1959 are Paris-Istanbul or Paris-Stockholm.

Air France expects initial deliveries of its 17 Boeing 707 jetliners in September, 1959. Carrier ordered 10 of the Boeings in 1956 and seven more last March. Last fall, faced with a financing problem, Air France borrowed $46 million from the Export-Import Bank and $15 million from private U.S. banks. Boeing and United Aircraft, the engine builder, also agreed to some $17.5 million of postponed payments.

The airline is expected shortly to pick

up its option on 12 additional Caravelles. The dollar position of the French government probably excludes any further equipment purchases in the U. S. in the near future.

France's other air carriers, TAI, UAT and Air Algeria all describe 1957 as a good year. Under a five-year agreement with Air France, which runs out in 1960, these private carriers have divided up operating rights within the French Union.

Repeated attempts to launch a domestic air service within France, which would be jointly owned by Air France, the state-owned railways, private airlines and banks and insurance companies, made little headway during 1957.

TAI, which has exclusive rights among French carriers to routes beyond Saigon to Australasia, will shortly begin using its three DC-7s on the long-range route. TAI's ton-kilometers in 1957 rose to over 38 million from 36 million in 1956. The line carried 62,751 passengers compared with some 53,000 the previous year. TAI already has ordered two Douglas DC-8 jetliners for delivery in May-June 1960. The government willing, TAI probably will order a third DC-8.

TAI is also involved in the current U. S.-French bilateral talks. It hopes to get U. S. approval of a Tahiti-Honolulu-West Coast route. TAI would thus be able to carry traffic from its Australian and New Zealand points up to the U. S. West Coast.

TAI last September began weekly service between Saigon and Djakarta, Indonesia. Line hopes to extend this service eastward toward Australia and New Zealand. At present these two countries are served direct from Saigon.

UAT, with routes from France to African points, is not satisfied with the 1955 air agreement among French carriers. It would like, among other projects, to serve certain French cities which up to now have no air links with Paris. It would also like to get government permission to order more Douglas DC-8s. UAT ordered three additional Nord 2502 Noratlas transports for its African routes, bringing its Noratlas fleet to seven.

Air Algeria's traffic during 1957 was increased, as it has been for some years, by the continued war in Algeria. The company is expected to announce early this year an order for three Caravelles.

Germany

Lufthansa German Airlines flew 536,395,000 revenue passenger miles in 1957, an increase of 57% over the previous year. Passengers carried rose 68% to 386,000, cargo was up 63% and mail increased 53%. Last year was Lufthansa's third year of operation since its post-war rebirth.

The German airline carried 37,410 transatlantic passengers during 1957. New Lockheed 1649 Super Star Constellations were put on this run in February. Fleet includes four of these aircraft, eight Super G Constellations, nine Convair 440s, three DC-3s, eight Chipmunks and two SAAB Safirs. Latter two types are used for training.

While figures are not yet available, the airline lost money last year, as it has each year so far. Lufthansa does not expect to show a profit until 1960.

Great Britain

British European Airways last year was in the middle of a still unsettled controversy between the government and aircraft manufacturers over a new jetliner for the airline's short to medium stage lengths.

Government efforts to force amalgamation in the aircraft industry resulted early this year in a joint proposal by Bristol Aeroplane Co. and the Hawker Siddeley group to build a three-engined, 99-passenger jet designated the Bristol 200. BEA, however, favors another proposal, the de Havilland 121. The government now has authorized BEA to negotiate for 24 of the de Havilland planes although formal announcement has not been made. The de Havilland group which will build the plane includes Hunting and Fairey.

One of them, Vickers, dropped out after getting a contract from British Overseas Airways Corp. for 35 VC-10 jet airliners.

BOAC's intention to order the four-engined jets was announced early last year, the order officially placed in January, 1958. The record $168 million contract calls for delivery of the aircraft, which will gross 299,000 lb., beginning in 1963. BOAC expects to be able to operate the VC-10 on all its routes in both hemispheres, and has optioned an additional 20 of the planes. It is now believed possible that the airline may sell its Comet, Britannia and Boeing aircraft and operate an all-VC-10 fleet after 1965.

The VC-10, Bristol 200 and de Havilland 121 design feature aft-mounted engines.

BOAC's overall load factor for 1957 was 62.2%, off slightly from 63.3% in 1956. Total passenger-miles flown last year were 1,318,887,000, up from 1,165,610,000.

The company's 1957 operating revenue totaled $141.5 million, up from $124 million in 1956.

The airline's Britannia 102s went into service last February, and in December the first Britannia 312s were put into transatlantic operation. They were the first turbine aircraft on this run. The 102s carried 77,500 passengers during the first year of their operation, flying 8 million miles and 28,000 revenue hours. Despite early flameout troubles with their Proteus engines, BOAC reports achieving a 72% load factor with the 102s and a 1,050-hr. time between overhaul for the engines.

The airline received Douglas DC-7Cs last year and put them into transatlantic service. The DC-7Cs also began serving San Francisco last year and a connecting service there with Qantas Empire Airways was inaugurated. Britannia 312s will serve San Francisco this summer as well as other U. S. points.

Initial deliveries of BOAC's Comet IV equipment are scheduled for 1959 and Boeing 707s will begin arriving in 1960.

BEA experienced its best year to date in 1957, earning a net profit of $3.36 million, up 20% from the year before. Passenger traffic was up 13% for a total of 2.75 million for the period.

BEA flew 926,010,000 passenger miles in 1957, an increase of 16.5%. Passenger load factor was 70.3%, up from 69.3%. Freight ton miles increased 10.3% to a total of 9,747,000.

The airline attributes its good 1957 financial results to all-around savings in expenditure. Staff productivity rose 8.3% to 14,000 capacity ton miles a year per employe.

BEA took delivery of its first Viscount 806s last December and expects to have 12 in operation by this summer, with the total order of 18 delivered by August. Its Viscount 802s were put into operation last year. Delivery of Vickers Vanguard long-range turboprops is scheduled to begin in 1960.

By June, the airline expects to be using the new Gatwick Airport for most of its London-Channel Island services.

Holland

KLM Royal Dutch Airlines took major steps during 1957 in expanding its fleet and adapting it for the turbine age. The carrier also added important cities to its route pattern and was involved in a U. S.-Dutch dispute over landing rights in this country.

Nine Viscount 800s went into KLM service last year and orders were placed for eight Douglas DC-8s, 12 Lockheed Electras and two Fokker F-27 turboprops. KLM was the first European carrier to order the DC-8. Ten piston DC-7Cs were added to the fleet during 1957, another DC-7C and a 1049 H Constellation were ordered, and four more DC-7Cs and one additional 1049 H were optioned.

The Dutch airline carried 920,000 passengers last year, up from 820,000 in 1956. Two million passengers will be carried by KLM in 1960, according to the carrier's prediction.

Bilateral talks between the U. S. and the Netherlands stalled and were resumed during the year and resulted in

granting of two of three KLM requests —Amsterdam-Montreal-Houston-Mexico City and Amsterdam-New York-Curacao. But the Dutch still want authority to serve Los Angeles from New York. KLM opened the Houston and Curacao services during the year.

The airline ordered flight simulators last spring for its DC-8s and Electras, and put into operation simulators for the DC-7C and Viscount. A new engine workshop is under construction at Amsterdam for overhaul of DC-8 engines.

In May, 1957, common shares of KLM were officially listed on the Amsterdam and New York stock exchanges. At the same time $7.5 million in new shares were issued in the U.S.

India

Indian Airlines Corp. expects to carry more than 600,000 passengers in 1958, compared with 571,106 in 1957 and 500,363 in 1956. Last year IAC added five Viscounts to its fleet of Dakotas, Vikings, DC-4s and Herons, and plans to add five more this year. IAC carried 5,221 tons of mail and 50,194 tons of cargo in 1957, but continued to run at a net loss amounting to $2,284,590.

Air-India International added to its 1049 Constellation and Super G equipment, will receive more Super Gs this year. Three Boeing 707s have been ordered for 1959 delivery.

During the first nine months of last year, AII operated seven flights a week to London, two to Tokyo, two to Nairobi and one to Sydney adding Djakarta as a port of call to the route which goes from Bombay via Madras, Singapore and Darwin. During this period, it carried 79,825 passengers, 3,256,000 lb. of general cargo and 1,353,000 lb. of mail.

Total revenue during the period was $17,570,000, with expenses running nearly as high to yield a net profit of $1,512,000.

AII is still trying to extend its routes to Peking and Moscow. The Russians, already operating a Moscow-Delhi flight via Kabul, Afghanistan, are said to be willing to cooperate. But since AII is a member of International Air Transport Association and the Russians are not, the question of air fares continues as a major hitch. New Delhi now is suggesting a pool of earnings shared in a fixed ratio. So far Moscow has declined to consider this compromise.

Israel

El Al Israel Airlines' big event of 1957 was inauguration of transatlantic service with the long-range Bristol Britannia. El Al has received three of the turboprop transports, expects its fourth in August.

The Israeli carrier began Britannia service last December, replacing its 049 Constellation schedules. Peak schedules this summer will be five weekly.

The Constellations were put into El Al's European services and five C-46s which formerly had handled part of this service were sold. First regular scheduled services to several European points were inaugurated in 1957.

Arkia Inland Airlines, El Al's domestic subsidiary, got three DC-3s in the C-46 trading for its internal routes. Arkia's fleet includes two Twin Beechcraft.

El Al's entire fleet now consists of the Britannias and four 049s.

Italy

Italy's two leading airlines, Linee Aeree Italiane and Alitalia, became one last year as the result of a merger following a three-month study by a governmental commission. Alitalia on Nov. 1 began flying all routes formerly operated by the two carriers.

The move was designed to improve Italy's commercial aviation competitive position and to end certain unsatisfactory conditions within LAI. These were said to include operational and administrative inefficiencies attributed chiefly to an involved financial structure and military rather than civilian supervision.

While LAI's record included a series of fatal crashes, Alitalia's safety record with American planes was perfect. Its only accident had involved a wartime wooden plane and sabotage was suspected in that incident.

Alitalia is flying the combined routes, which include domestic and international services, with DC-7C, DC-6B, Viscount, Convair 340 and 440 and DC-3 equipment. It received its first 7C deliveries last year, plans seven weekly flights from New York by April 1.

LAI had ordered four Lockheed 1649A Constellations for 1957 delivery. Alitalia, however, sold the aircraft to Trans World Airlines last December, just before their scheduled delivery to the Italian line.

Alitalia has placed no turbojet orders yet, but a company team has been studying the Boeing, Convair and Douglas jets, as well as the Caravelle and the Vanguard turboprop. The airline's management has previously expressed a belief in homogeneity of equipment where possible.

The airline's capital is expected to be at least doubled by this spring, through government subsidy and-or private investment.

Japan

Japan Air Lines went ahead last year with its 10-year plan to become a major international carrier with a world-wide route pattern. Schedule called for no route expansion during 1957, but the first JAL DC-7C was delivered, three more are expected by May, 1958, and important route developments are planned this year.

Operating revenues of JAL for the period from October, 1956, through September, 1957, totaled $24,374,550, with a profit of $3,122,750. The airline carried 45,527 international and 377,030 domestic passengers in 1957, flew a total of 312.8 million passenger-miles with a domestic passenger load factor of 75.7% and an overseas passenger load factor of 71.5%.

New services scheduled for 1958 include thrice-weekly Bangkok-Singapore flights; monthly service beyond San Francisco to Mexico City, Caracas, Belem, Rio de Janeiro and Sao Paulo; an increase from five to seven weekly Tokyo-Honolulu-San Francisco flights, and service to Los Angeles on three of the trans-Pacific flights if the U. S. approves.

Japan Air Lines increased its capitalization last year from $15.9 million to $19.9 million.

The carrier predicts a 1958 increase to 66,012 overseas and 446,650 domestic passengers, with respective passenger load factors of 73.8% and 77%.

A new Japanese domestic airline, All Nippon Airways, was created last December with the merger of Far East Airlines and Japan Helicopter and Airplane Transport Co. Capitalization of the new carrier is $1.7 million and its fleet includes DC-3s, de Havilland Doves and Herons, Bell 47 helicopters, Piper Tri-Pacer and Auster Autocar.

Mexico

Provisional bilateral agreement signed last March between the United States and Mexico resulted in the biggest year in Mexico's 33-year history of commercial aviation, and 1958 promises to be even bigger.

The past few months have brought new nonstop flights from Mexico City by Eastern Airlines to New York and New Orleans; by Aeronaves de Mexico to New York; by Western Air Lines to Los Angeles, and by both Compañía Mexicana de Aviación and American Airlines to Chicago. Only route yet to be inaugurated is that by Aeronaves to New Orleans.

The provisional air agreement extends until June, 1959. After seeking the agreement for 11 years, several airlines have found after a few months of operation that the routes are not automatic money-makers.

Aeronaves in 1957 became the first airline in the Western Hemisphere to offer Britannia service. The airline had hoped to inaugurate its New York route in October, but delivery delays postponed inauguration until December. When Aeronaves started operating the

route on Dec. 16, mechanical troubles denied full use of its two Britannias until late December.

Thus far, on the New York run, Aeronaves has been operating with only a 25%-35% load factor. If, as some reports suggest, Air France is limited in the near future to booking only through traffic to Europe, Aeronaves for a while would be the only carrier offering tourist class service to New York. However, Eastern is not overlooking the possibility of beginning tourist service as soon as traffic warrants.

Although the New York run was the most highly publicized route resulting from the bilateral, the fiercest competitive fight is developing over the Chicago nonstop, shared by American Airlines and Cia. Mexicana de Aviación.

Mexicana initiated Chicago service Oct. 15 and reports that it lost $8,000 daily for the first two months until Christmas business and Mexico's peak tourist season arrived. Now, Mexicana says, it is doing well but is worried about what will happen when tourism slacks off, usually in March. Both Pan American World Airways, which owns nearly 42% of Mexicana, and United Air Lines are feeding Mexicana in Chicago and in Los Angeles.

American Airlines was delayed by interpretations of the bilateral and did not begin its nonstop Chicago service until Jan. 5th.

American has begun to dig in for a fight with Mexicana for what it terms "unfair" airline practices on Mexicana's part. Mexicana on its DC-7Cs uses the same two-and-two configuration for tourist-class as it does for its first-class passengers on the same plane, serves free meals to its tourist-class passengers and will sell them drinks at low prices. American on its DC-7s seats its tourist-class passengers in a three-and-two configuration, sells them meals but doesn't sell them drinks. Mexicana says that it does not intend to discontinue these practices until the Chicago route is well built up.

Western operates only a first-class service to Los Angeles on a one-flight-a-day basis. Despite an average load factor of 55%-65% since it began service July 15th, Western, with its DC-6Bs, has not done too well in competition with Mexicana, which uses DC-7Cs and has several other flights into Los Angeles daily, although only one nonstop.

Guest Aerovias Mexico in 1957 suffered a difficult year. The airline had hoped to get the Chicago run but lost out to Mexicana. Guest claimed Chicago had been granted as a co-terminus with Windsor, Ontario, to which point Guest had been operating since February, 1956. After Mexicana started operating the Chicago nonstop, Guest discontinued its Windsor flight.

Guest, while legally a Mexican carrier, is owned largely by U. S. capital.

This year promises to be a better one for Guest. The carrier may inaugurate one-stop (Panama) service to Caracas. Guest says it has Mexican government permission and is awaiting clearance from the Venezuelan government. The political situation in Venezuela, however, may delay Guest's clearance.

In the newly-developed competition between U. S. and Mexican carriers, the American lines generally are not going all out to take all the business they can. As long as the bilateral agreemen is provisional, the U. S. companies apparently do not want to endanger that agreement or to have to defend themselves against "Colossus of the North" charges at time of renegotiation.

The one exception is American's competition with Mexicana over Chicago traffic. The Mexican government knows that Mexicana is not only Mexico's oldest and largest airline but that it is a strong, money-making business. American cannot be accused of "picking on a small Mexican company" as, for example, Eastern could if it permitted itself to engage in a bare-knuckle fight with Aeronaves, making its first international venture into New York. American won't have to hesitate about slugging it out with Mexicana.

Scandinavia

Scandinavian Airlines System earned $2 million in net profit last year, about the same result as in 1956. Figures apply to the fiscal year ending Sept. 30.

Total traffic revenue for SAS during the 1957 year was $88.9 million, up from $71.6 in 1956. Other revenue brought the total gross to $96.1 million, compared to $74.5 million in 1956. Costs, including depreciation, were up from $72.5 million to $94.1 million, resulting in a similar net balance for each of the two periods.

SAS carried 1.4 million passengers on its system last year, up from 1.2 million. Freight totaled 25 million lb., off from 25.5 million in 1956. Mail was up from 10.8 million lb. to 11.4 million lb. Passenger miles flown totaled 990 million, up from 780 million.

Total ton miles sold by SAS last year were 111.8 million, up from 89.4 million.

SAS last year placed an order for six Sud Aviation twin-jet Caravelle transports, and holds an option for 19 more of the planes. First delivery is scheduled for 1959. The jets will complement seven DC-8s the airline expects to receive beginning in 1960.

Last February the Scandinavian carrier opened a second polar route, flying from Copenhagen to Tokyo via Anchorage, Alaska. This route was connected on Jan. 20, 1958, with new DC-7C service on a southern route from Europe to Japan via India.

SAS uses the DC-7C on both its polar routes. During the year, the Los Angeles-Copenhagen service became competitive for the first time as Pan American and Trans World Airlines began flying from the West Coast to Europe. SAS seeks to add San Francisco to its Los Angeles terminal.

The Scandinavian carrier during 1957 received the balance of deliveries on its DC-7C and Convair 440 equipment, these planes now totaling 14 and 15 respectively in SAS's fleet.

Spain

Iberia Air Lines of Spain expects final figures to show a 1957 total of passengers carried exceeding the million mark. The 1956 total was 673,343.

On its North and South Atlantic routes, Iberia carried 21,207 passengers last year.

The state-owned airline bought two 1049G Constellations last year, bringing the total of these aircraft in its fleet to five. Other equipment includes Convair 440s, DC-4s, DC-3s, and Bristol A170s. Iberia flies a total of 41,000 miles of routes, is concentrating its greatest traffic development drive on the Madrid-New York market and has doubled this service in the past year.

Switzerland

Swissair's 1957 revenues were $47 million, up from $35.6 million in 1956, and the company showed a net profit of $470,000.

New aircraft increased Swissair's available ton/km. by 5390, raising the European services total 5,090, the Middle Eastern 20%, North Atlantic 30%, and South American by 100%. Two Douglas DC-7Cs and four Convair 440s were added to the airline's fleet for a total of four 7Cs and 11 Convair 440s. Swissair also operates six DC-6Bs, three DC-4s and eight DC-3s.

The airline carried 992,911 passengers last year, an increase of 28%.

Route expansion included service to Tokyo, extension from Beirut to Baghdad and Dharan and new connections in Europe. South American and North Atlantic schedules were increased.

With the increased capacity, load factor declined from 66.5% to 61.6%.

Swissair's plans for nonstop transatlantic service with the DC-8s it expects in 1960 are threatened by a problem at Kloten Airport at Zurich. Present space is inadequate for jet maintenance, and a public referendum was held last June on a proposal to double existing facilities at a cost of $11.6 million. The proposal was voted down by a large majority, and some means still is being sought of providing the facilities in time for DC-8 service.

● AIR TRANSPORT

Restrictions Dampen Local Outlook

By Ford Eastman

Washington—Little improvement in the financial standing of local service airlines is predicted this year despite expected gains in traffic, operating revenue and route expansion.

Although developments over the past few months have raised local carriers' hopes for a brighter outlook in the future, they claim they are still plagued with many problems that must be solved before the industry can attain self-sufficiency. How quickly this is accomplished depends upon the speed with which the Civil Aeronautics Board takes action to remove restrictions that hold back the industry from making sound financial progress, an industry spokesman said.

Operations Losses

During the last year local airlines registered substantial increases in every category except the net operating income column. The industry losses resulting from operations were almost three times greater in 1957 than in 1956. Here are the results as compared with the previous year:

- **Operating revenue** jumped from $67,711,000 in 1956 to $80,512,000 in 1957, an increase of 19.1%.
- **Operating expense** increased 20.1%, hitting a high of $82,374,000 as compared with $68,339,000 in 1956.
- **Net operating income** dropped from a minus $628,000 in 1956 to a minus $1,862,000 last year.
- **U. S. mail service** pay failed to keep pace with other traffic growths and increased only 8.7%, from $1,107,000 to $1,203,000.
- **Federal subsidy** jumped 20.8%, from $23,211,000 in 1956 to $28,037,000 last year.
- **Revenue plane miles** went up from 60,529,000 to 68,402,000, an increase of 13%.
- **Passenger load factor** increased from 48.3 to 49.9, or a total of 1.6%, while the average passenger load went up only .5% from 10.7 to 11.2.

Dissension over operating methods and basic policy last year broke up the Conference of Local Airlines, an organization which was largely instrumental in obtaining legislation that gave local airlines permanent status on their routes in 1955.

Resignations

Charging the Conference with "lack of aggressiveness" in attacking local airline problems after permanent certification had been obtained, six western carriers resigned, leaving the Conference with seven members.

The six formed a new group known as the Association of Local and Territorial Airlines (ALTA) with Joseph P. Adams, former member of the CAB, as counsel and executive director. The six were West Coast Airlines, Bonanza Air Lines, Central Airlines, Ozark Air Lines, Lake Central Airlines and Frontier Airlines. The membership now totals nine with Alaska Airlines, Reeve Aleutian Airways and TPA-Aloha Airlines of Hawaii.

New group embarked upon an ambitious program and secured the passage of the Guaranteed Loan Bill during the last session of Congress. This year they plan a program pledged to "improve passenger travel, reduce subsidy and strengthen member airline finances."

Passage of the Guaranteed Loan Bill was considered one of the most important single developments since the permanent certification legislation. Purpose: to permit the government to guarantee 90% of loans up to $5 million for the purchase of new equipment. Because of their poor financial status local lines said they found it difficult to obtain loans for modern airplanes to replace the obsolete DC-3s. CAB has taken no action on loan applications to date.

Local carriers feel that one of the most important steps toward self-sufficiency is the modernization of their fleets.

Without modern aircraft, industry would be forced to stay on subsidy indefinitely, carriers contend. Many look to the Fairchild F-27 turboprop as an answer.

Local airlines also feel that before the problem is completely solved they must be permitted to retain capital gains from the sale of old equipment for

Growth of Local Service Airline Industry

(000 omitted)

	1956	1957	% Increase
Revenue Plane Miles	60,529	68,402	13
Revenue Passenger Miles	644,994	765,990	18.8
Revenue Ton Miles	66,474	78,368	17.9
Revenue Passengers	3,516	4,225	20.1
Operating Revenue	$67,711	$80,512	19.1
Operating Expense	$68,339	$82,374	20.5
U. S. Mail Pay	$1,107	$1,203	8.7
Subsidy	$23,211	$28,037	20.8
Net Oper. Income	$−628	$−1,862	....
	1956	1957	% Increase
Average Passenger Load	10.7	11.2	0.5
Passenger Load Factor	48.3	49.9	1.6

Local Service Financial Results—1957

(000 omitted)

Airline	Operating Revenue	Operating Expense	Subsidy	Net Operating Income (Before Taxes)
Allegheny	$8,443	$8,483	$2,863	$−40
Bonanza	3,348	3,511	1,231	−163
Central	4,006	4,249	2,383	−243
Frontier	6,443	6,516	2,416	−73
*Lake Central	3,478	3,492	1,759	−14
Mohawk	7,814	8,281	1,899	−467
North Central	9,682	10,691	1,599	−1,009
Ozark	7,483	7,444	3,041	39
Piedmont	8,329	8,211	2,488	118
Southern	4,439	4,578	1,939	−139
*Southwest	6,018	5,947	1,770	71
Trans Texas	6,694	6,546	2,976	148
West Coast	4,335	4,425	1,673	−90
Total	80,512	82,374	28,037	−1,862

* 11 months actual, Dec. estimated

Source: Ray & Ray, Wash., D. C.

down payments. Legislation along this line has passed the House and is now in the Senate.

Probably the most important step that could be taken to help local airlines attain self-sufficiency, they contend, is the strengthening of their route structure. This, an airline spokesman said, can be accomplished by lifting operating restrictions rather than the award of additional routes in most instances.

Biggest need cited by local carriers is the opportunity to serve the large cities or markets on their present routes on a one-stop or non-stop basis.

At present most carriers must make two or more stops between major points and on some segments they are permitted to skip certain stations after serving that community with a specified number of round trips daily.

Restrictions

ALTA contends that if the operating restrictions of local carriers were relaxed or eliminated within each carrier's market area, their traffic density would increase, as would the average length of passenger trip.

Adams added that not only would their revenues increase sharply, but their unit operating expenses would decline.

He said the skip-stop authority, recommended in many of the route cases now pending before the CAB, is not the answer to better performance. He feels that an airline should not be required to make several daily stops at a community which generates only one or two passengers a day.

Proceedings now before the CAB in which route modifications, extensions and some lifting of restrictions are involved, include: The Great Lakes Local Service Case, Seven States Case, Northeastern States Area Case, Pacific Northwest Area Case, Montana Local Service Case, Southeastern Local Service Case and the Piedmont Local Service Case.

Improvement

Other areas of improvement suggested by ALTA where local and territorial airlines could be strengthened are:

- **Joint use of facilities** and joint purchasing.
- **Consolidated engine** overhaul facilities for turbine power plants.
- **Revision of CAB** temporary mail rate procedures to permit the fixing of more adequate temporary rates and to include sufficient return on investment to permit the carriers to meet interest charges.
- **Adoption by CAB** of a more lenient mileage disallowance policy.
- **Base disallowances** in mail rate cases on overall efficiency instead of disallowing costs in a particular category in which costs may be high.
- **Provide for depreciation** period of no more than seven years (three years and 10% residual value for DC-3 aircraft) in view of the difficulty of loan retirement when depreciation periods are longer.

Fare Increase

A more recent development, the proposed fare increase designed to aid domestic trunklines, is not expected to help the local service airline financial picture. However, it will reduce federal subsidy from $5 million to $7 million a year, providing there is no loss in traffic as a result. Some airlines feel that the increase as applied to local carriers might retard traffic growth.

By applying the increase to the carriers' 1957 third quarter operating results, here is the effect it would have:

Airline	Per Cent of Fare Increase:	Yield:
Allegheny	12.7	7.62
Bonanza	12.0	6.74
Central	12.5	6.97
Frontier	11.1	6.69
Lake Central	14.5	7.14
Mohawk	12.1	7.57
North Central	12.9	8.24
Ozark	13.8	7.24
Piedmont	12.2	7.15
Southern	13.5	6.83
Southwest	13.0	6.16
Trans-Texas	11.6	6.85
West Coast	15.7	6.36
Average	12.7	7.18

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PROBLEM	ANSWER	DESCRIPTION
		ALUMINUM BRIGHTENING
Removing surface corrosion residues	1-2767-C	A medium-duty brightener. Removes surface corrosion residues. Brightens without corroding surfaces. Meets Specification MIL-C-25378.
Rapid removal of tarnish and corrosion from aluminum	PHOS-IT*	A rust remover and metal conditioner for rapid removal of tarnish and corrosion from aluminum. Also, for preparing aluminum, iron, steel, and zinc for painting.
		CARBON REMOVERS
Cold tank carbon removing	P-1075	A nonflammable cold tank carbon remover for grease, oil, carbon deposits from jet and piston engine parts. Noncorrosive—excellent for stripping paint from base metals.
		AIRCRAFT EXTERIORS
Exterior cleaning	AEROWASH LR-231	A water-base emulsion cleaner for washing painted aircraft surfaces. Meets MIL-C-25769.
Emulsion cleaning	1508	An outstanding emulsion cleaner—meets Specification MIL-C-25179-A—will not craze plastics. Excellent for white paint.
		EXHAUST STAINS
Carbon removing	SPRAZEE*	A heavy-duty paint stripper—excellent for removal of heavy, caked and baked-on carbon in the exhaust area.
Removing exhaust stains	No. 20	For removal of exhaust stains. Prevents corrosion in exhaust-stained areas. For stubborn stains, use without diluting.
		INTEGRAL FUEL-TANK DESEALING
Removing sealing compounds	No. 2789	For removing all types of sealing compounds. Especially active in removing polysulfide polymers.
Tank spotting	444-C	Apply by brush on spots or patches of sealing compound not removed in normal desealing operations. Swells sealant and breaks bond-to-metal, makes removal easy.
		PAINT REMOVERS
Paint removing	SPRAZEE*	A heavy-duty, fast-acting, free-rinsing stripper. Safe on aluminum, magnesium, steel, and other aircraft metals.
Paint removing	P-1075	Superior tank-type remover for aircraft finishes.
		OIL AND WATER ABSORBENT
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AIRCRAFT MANUFACTURE

PROBLEM	ANSWER	DESCRIPTION
		ALUMINUM CLEANING
All-purpose aluminum cleaning	ALTREX*	A nonetching, soak-tank aluminum cleaner for rapid removal of marking inks and soil from aluminum alloys.
Deoxidizing aluminum prior to spot welding	2487	Room temperature deoxidizer for removing oxide films and reducing contact resistance of aluminum alloys to proper welding requirements of less than 50 microhms.
Power washers	SPRAY-ALTREX	An effective cleaner for aluminum and other metals; developed for use in spray washers.
		MAGNESIUM CLEANING
Heavy-duty soak cleaning	W.L.G.*	A versatile, heavy-duty soak cleaner for removing heavy oils, greases and drawing compounds. Phosphated to condition water—silicated for better cleaning action. No soap scums!
Alkaline cleaning	ALTREX*	For cleaning aluminum and magnesium in the same tank. Eliminates soap scum in hard water. Removes most oil, drawing and stamping compounds.
		STEEL CLEANING
Heavy-duty soak cleaning	W.L.G.*	A versatile, heavy-duty cleaner for removing greases, oils, and drawing compounds. Cleans heat-treated, oil-quenched stainless steel.
Heavy-duty electro-cleaning	F.S.*	For cleaning steel prior to plating; removing carbon smut when used with reverse current; cleaning magnesium, copper, bronze, and iron castings.
Alkaline rust and smut removing	FERLON	A new product for removing rust, oxides, and smut from steels, including stainless steels.

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Air Cargo Scores Impressive Gains

Washington—Air freight business last year scored one of its biggest gains in history with ton-miles carried passing the 400 million mark for the first time.

Prospects for a continued expansion of the air cargo market in 1958 appear bright despite a decided dip in traffic volume during the final quarter of 1957. Estimated gain of 19% for 1958 will fall only slightly short of the impressive 22% increase registered in 1957 over the previous year.

Freight ton-miles of the domestic scheduled airlines including local service helicopter and all-cargo carriers totaled 407 million in 1958 compared with 330 million the previous year. For the domestic industry, mail was up 6.6% in ton-miles handled but express plummeted from 51 million ton-miles to 45 million—a 12.2% drop.

On the all-cargo carriers record, mail ton-miles jumped 33% and express ton-miles burgeoned into a 106% increase.

Shortcomings

Despite the favorable showings, air cargo officials have not been carried away with enthusiasm over the record. They emphasize that the airlines have barely tapped the air cargo market potential and point to the lack of aggressive promotional and public educational programs as an industry shortcoming.

According to one estimate, the airlines last year captured a meager ½ of 1% of all available intercity cargo traffic while more than one-half of available cargo space on aircraft was flown empty.

During 1957, a number of projects designed to spread more detailed air freight information among shippers were formulated under the sponsorship of the air cargo division of the Air Transport Assn. Plans are to launch these projects this year.

But most cargo men now fear that the tight money situation within the industry may force managements to shelve such programs and divert cargo budgets into other areas of operation as an economy measure. Action of American Airlines last year in canceling an order for cargo aircraft and in dropping a program involving the acquisition of a commercial version of the Lockheed C-130 cargo transport because of slackening revenues and rising costs intensified the pessimism of cargo officials.

Need Economical Freighter

Most cargo officials are convinced that only the introduction of an economical, high-capacity freight plane will permit an impressive entry into the freight market. Use of the converted conventional passenger aircraft as a freighter has been a marginal operation at best.

And high ground-handling costs often offset revenues derived from freight carried on combination aircraft which today still account for about 60% of all air freight handled.

C. E. Woolman, president of Delta Air Lines, admitted to the economic problems of air freight in a recent address but refused to relegate cargo business to a second rate position. He said:

"The airlines have been accused at times of treating air freight as a stepchild. This is not true. Whatever lag there has been in the promotion and development of this type of service has been due to economic and equipment problems rather than any lack of appreciation of the potential of air freight or lack of desire to develop such."

Bright Outlook

Cargo revenues last year topped $82 million compared with the $8 million grossed in 1947, the year scheduled carriers began to take cargo business seriously. Growths up to 500 million ton-miles by 1960 and to 800 million ton-miles by 1965 are forecast.

These predictions could be outstripped if new sales technique adopted by some carriers take hold. At least two airlines, American and United, have introduced scientific sales methods designed to show how distributing costs can be sliced through the use of air freight. Last year, at least a dozen major industrial concerns either sharply reduced or eliminated entirely warehousing facilities through the adoption of air freight distribution plans suggested by the airlines.

Taking full advantage of this first significant breakthrough into heavy industry, leading airlines offered shippers detailed programs that pointed up how savings can be effected through air

freight by reducing the cost of maintaining inventories, packaging and warehousing costs, breakage and pilferage losses and insurance expense.

Wide-spread expansion of these sales techniques could have far-reaching results since the cost of distributing most goods today amounts to more than 50% of the total cost of the goods sold.

Delta joined American and United last year as one of the only three trunkline carriers to operate all-cargo fleets. TWA withdrew its fleet of DC-4 cargo aircraft in mid-1957. Flying Tiger Line late last year began the operation of its fleet of 12 Lockheed 1049H Constellations.

Expansion

By October, Delta has expanded its all-cargo service to 14 key cities on its system with five D-46 (modified C-46) freighters. The airline's air freight ton-miles during the year climbed 23% and air mail ton-miles rose 10%.

American Airlines continued to hold first place in air freight volume among the scheduled carriers. However, its forecasted increase of 20% in 1957 over 1956 did not materialize because of the general fall-off of business during the last three months of 1957. The airline handled 86-million ton-miles of airfreight last year—a 15% increase over 1956.

United carried an estimated 58 million ton-miles of air freight last year for a 14% increase over 1956.

The airline expects 1958 growth will be comparable to the 1957 rate of expansion.

Capital Airlines early last year began experimenting with cabin-loading of cargo on passenger aircraft as a means of improving payloads on late night flights that normally operate at low load factors. From two to 12 seats are reserved by the cargo department each day and mail and freight are loaded in the front rows of seats no higher than seat-back level.

Capital has stamped the experiment as successful and reports the system has brought about a 60% increase in air mail ton-miles, a 27% increase in air freight and a 5% increase in air express—one of the few gains in express traffic shown last year.

Northwest has adopted a similar program on its late-hour DC-4 operations. By equipping the aircraft with adjustable seats that can be easily folded against the fuselage bulkheads, the airline can quickly convert the DC-4 passenger planes into a combination passenger-cargo cabin configuration or into all-cargo planes.

Air express suffered a severe setback during the year as a result of a paralyzing labor strike that began in April when Railway Express drivers walked off their jobs in seven major cities. Express traffic was brought to a virtual standstill in those areas until settlement in the labor dispute was reached late in July.

Only the all-cargo carriers and helicopter airlines showed increases in air express volume last year over 1956.

Mail traffic continued to increase last year with all-cargo carriers again showing the best gains. They reported a 33.7% increase in air mail ton-miles. Local service airlines and helicopter carriers each as a group had a 4.4% increase in mail ton-miles.

"All-Up" Policy

Prospects for a substantial improvement in air mail traffic in 1958 are good.

Congressional pressure for an "all-up" mail policy or all-mail by air movement is growing despite arguments by railroads that the surface-by-mail experiment began in 1955 is not proving successful.

Possibility that mail rates will be increased during the next session of the 85th Congress is strong but most observers do not feel that a rate hike will have a substantial effect on first-class mail volume.

Use of air mail parcel post by an increasing number of shippers is grow-

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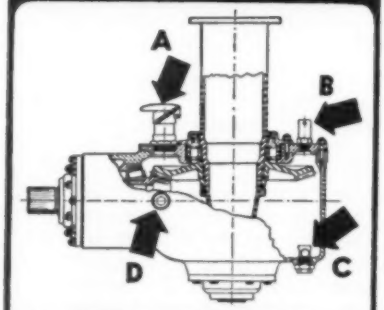

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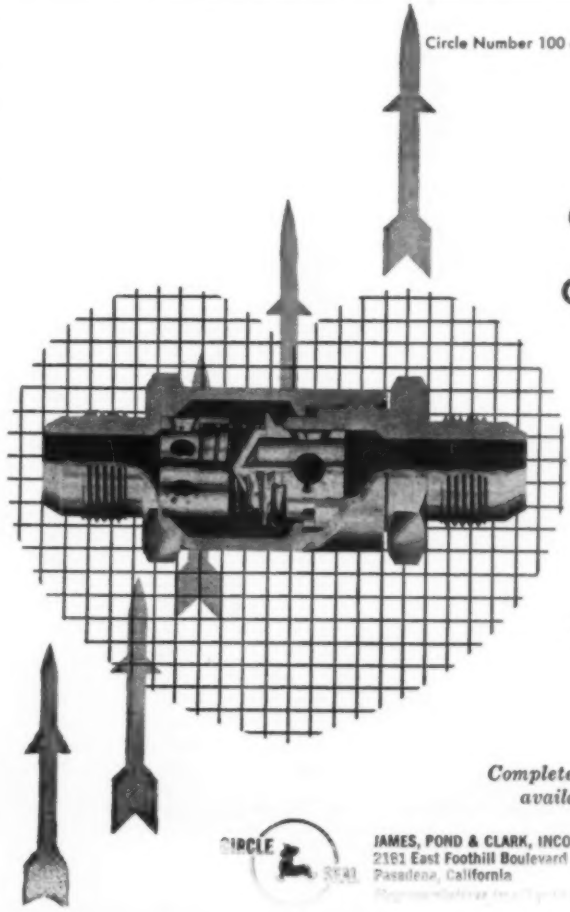

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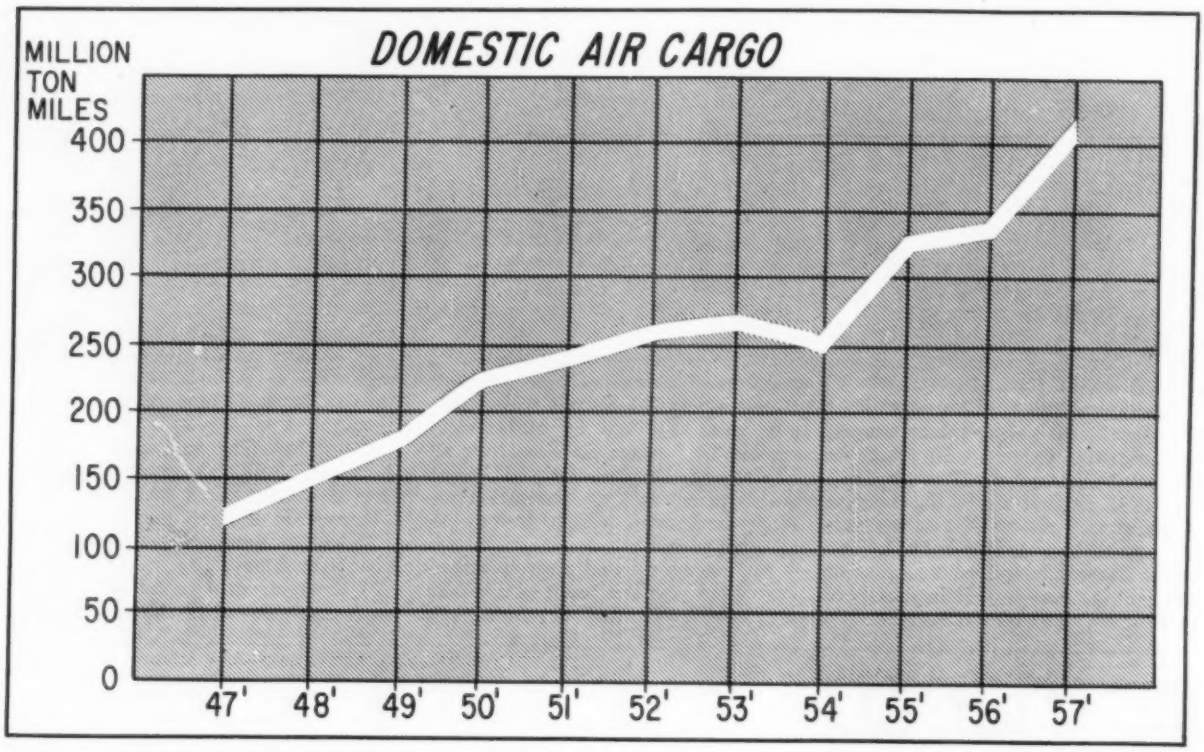
ing rapidly as an inexpensive means of expediting small packages. Incomes from this source of cargo activity will increase substantially in 1958. Overall mail traffic will probably show a gain in 1958 similar to the 7% increase recorded last year.

During 1957, air freight rates were increased by 10%. On a limited number of commodities, the boost was held to 5%.

Since cargo business in the first quarter of 1957 indicated that the carriers might enjoy a 30% gain in traffic, some observers attribute the subsequent decline in freight volume to the rate increase. However, most air cargo officials say the reversal later in the year was due to the economic recession and reflected the wide-spread dips in all other areas of transportation.



Air Cargo in Scheduled Service 1956—1957

	THOUSANDS					
	MAIL		EXPRESS		FREIGHT	
	1957	1956	1957	1956	1957	1956
TRUNKLINES						
American	19,884	20,041	8,999	10,750	82,408	71,283
United	28,600*	26,912	9,800*	12,739	56,960*	49,999
TWA	12,478	12,549	7,345	9,090	25,512	23,674
Eastern	11,203	11,353	5,297	5,373	15,636	14,823
Braniff	3,115	2,595	1,419	1,541	5,077	4,096
Capitol	5,168	3,257	2,373	2,261	4,517	3,556
Continental	1,083	870	458	316	1,561	1,242
Delta	4,248	3,823	2,882	3,219	9,002	7,221
National	3,228	3,289	611	703	5,193	4,986
Northeast	517	127	249	190	645	305
Northwest	4,750*	4,641	2,500*	2,720	9,280*	7,755
Western	3,084	2,211	1,095	805	2,890	1,649
CARGO LINES						
Aaxico†	34	3	144	33	2,056	112
Aerovias	.....	.....	.....	.....	8,849	7,503
Flying Tiger	449	364	422	298	82,986	54,958
Riddle†	511	.....	324	386	31,554	22,428
Seaboard†	.....	NO	.....	.....	17,939	7,697
Slick	846	787	719	547	49,800	47,719

*Estimate; †Certificated Service began during 1956 and figures do not cover entire 12 months of 1956

Commercial Jet Outlook Bright For U. S. Airways and Airports

Washington—Prospects of strengthening U. S. airways and airports in time to meet the challenge of commercial jet operations brightened substantially last year.

Airlines, airports and government agencies now mark 1957 as the turning point from a long period of stagnation in airway and airport development to a new phase of activity that presages solid progress from now on. Optimism over the future stems from these factors:

• **Airways Modernization Board.** Implementation of the Edward P. Curtis plan that resulted in the establishment of the interim Airways Modernization Board and envisages the organization of an all-encompassing Federal Aviation Agency represents the first step toward a wide-scale research and development program for a long-range airport and airway system. AMB, with a proposed budget of $35 million for fiscal year 1959, has already embarked on an ambitious research program through the letting of contracts to private industry.

• **Civil Aeronautics Adminstration.** Federal Airways Plan, designed to modernize airways to meet today's rapidly growing traffic demands, is progressing according to schedule. Although President Eisenhower's proposed budget for the CAA fell some $60 million short of anticipated requirements for fiscal year 1959, Administrator James Pyle intends to hold it to present accelerated pace in implementing the airways with more radar, ILS, high intensity approach and landing lights and other facilities to insure safe and efficient operations.

• **Certification rules.** As the result of certification requirements of turbine aircraft issued last year, airport planners now know for the first time such basic facts as runway strength characteristics needed to handle the jets.

• **Construction.** About $200 million has been earmarked for improved runways and taxi strips at major airports throughout the U. S. This amount is in addition to the multi-million dollar program involving the development of new terminals and terminal areas in major cities.

Step by Step

Despite the general optimism over the future of the airway and airport development, however, most airport operators are cautious in appraising the relationship of jet operations to airport capacity throughout the country. One official told AVIATION WEEK that "we'll handle the jets without too much trouble but we'll be working with basic facilities only. The frills that will give us complete efficiency will come later —much later."

In a paper presented to a special symposium at Phladelphia's Franklin Institute last year, E. Thomas Burnard, Executive Director Airport Operators Council, admitted that progress to date "keynotes" the arrival of jet transports but warned:

". . . development of the aircraft, and the desires of the public for air transportation, have been so demanding since 1946 that even these great achievements are in danger of obsolescence and inefficient use unless a number of technical answers are soon found and integrated into developments."

Data Need

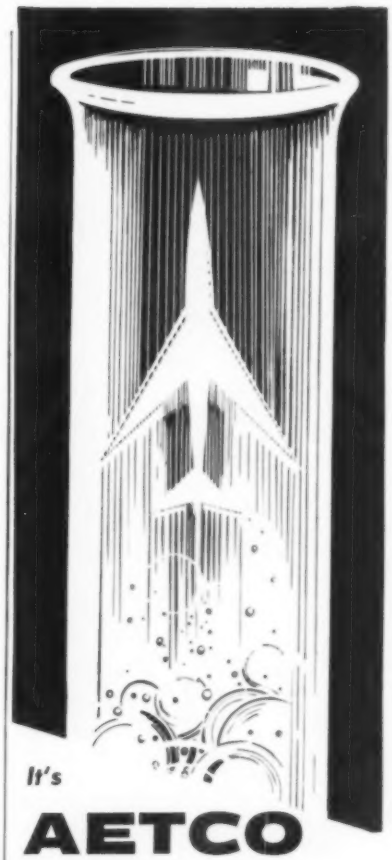
Burnard also pointed to the need for more specific information from the federal government and the airlines if progress in airport development is to continue unchecked. It is true that opinions on a number of requirements for jet operations vary to such a degree that sound planning for the future can become a risky venture.

For example, in a comprehensive survey conducted last year by Airborne Instrument Laboratories, length of runways needed to handle civil jet transports was set at a maximum of 10,000 ft. Other estimates place runway length requirements at 8,000 ft. Air Transport Assn. calls for 11,500 ft. but Air Line Pilots Assn. has unofficially declared that a length of 13,500 ft. is the absolute minimum necessary to handle all types of jet operations.

Nevertheless, despite such differences, airport users reached unanimity of opinion on a number of points last year to give airport operators a go-ahead signal for some facilities construction. Last year, military users accepted the civil high-intensity centerline landing-light configuration to resolve that controversial issue.

The Civil Aeronautics Administration is operating two types of high-intensity approach light configurations —one at New York International and one at Washington International—in hopes that users will agree on one or the other through actual use of both so that a standard can be adopted this year. CAA last year conducted a series of tests on high-speed runway turn-off patterns and the Airways Modernization is making similar studies now so that standards should be available sometime this year.

Meanwhile, airports individually spurted ahead to improve terminal area



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facilities. Dallas, Miami, Portland, St. Louis and Cleveland recently either completed or began multi-million dollar projects for new terminal facilities. Los Angeles started construction in December of a $46 million jet-oriented terminal at Los Angeles International Airport. The new terminal is planned to accommodate 9 million passengers in 1965, 13 million in 1970.

In December, the main building of a $150 million "Terminal City" at New York International Airport was dedicated. This represents one phase of an over-all plan which, when completed, will involve a total investment of more than $300 million.

Minneapolis-St. Paul launched plans to begin a wide-scale airport improvement program. A $30 million bond issue for airport development was held up by delaying actions of a citizens air safety league organized as a result of a crash of a military aircraft into a private residence. This issue has been settled in courts and the airport development project is now underway.

Chicago withheld a bond issue for runway improvement at O'Hare Field pending a decision by the CAA's Technical Development Center at Indianapolis on the best location for a proposed runway. TDC's decision has been turned over to the Air Transport Assn. and the CAA for final coordination with the City of Chicago.

Early this year, the Airways Modernization Board recommended Chantilly, Virginia as a site for a second airport to relieve congestion at the Washington (D. C.) National Airport. Last year, Congress appropriated $12.5 million as funds to begin the construction of the second Washington airport.

Federal Aid

During the past three years, funds have been available to airport operators for airport development through the federal aid to airports program. Under the plan, which expires in fiscal year 1959, airports are granted by the federal government one-half the funds required for approved development projects.

The importance of continuing the program beyond the present expiration date has been emphasized by E. Thomas Burnard who warns that, because of high costs, ". . . local voters will continue to look skeptically at, or oppose, airport bond issues which must compete with schools, streets and other community issues." He adds:

"The huge sums of money going into aircraft and airways development must somehow be matched in airport development, and when multi-million dollar airport facilities are built, they should be built right."

Burnard says that airport facilities needed for jets of tomorrow should have been known at least three years ago. He points out that because airports are financed on long term basis of 20 to 30 years, it is imperative that aeronautical needs are known well in advance of their construction. Here are the technical problems which Burnard has urged the Airways Modernization Board to tackle as soon as possible:

- **Runway and taxiway configuration.**
- **Visual aids.**
- **Ground traffic control.**
- **Multiple airport configurations.**
- **New airport locations.**
- **Airport layout.**

Milton W. Arnold, Air Transport Association's vice-president-operations and engineering, last year termed airport facilities now available and those planned for the future sadly deficient in meeting the nation's aviation demands. Arnold said that aircraft noise is a "serious consideration that cannot be overemphasized."

He warned that many airport shortcomings will be more pronounced in jet operations. For example, he said that a deficiency in airport landing and in visual aids will result in poorer jet transport reliability than piston reliability. Poor wind orientation of runways also will adversely effect jet operations to a greater degree than piston planes.

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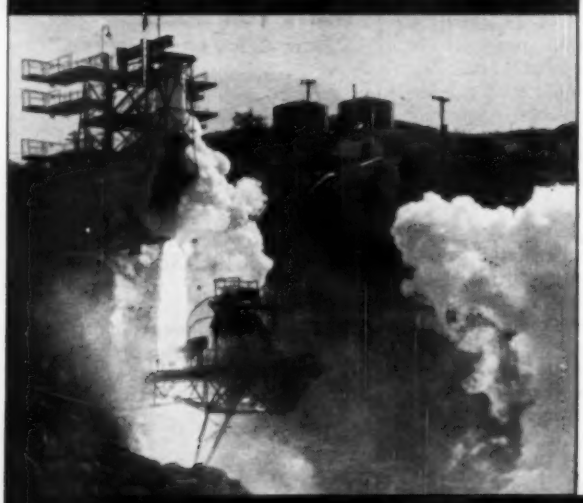

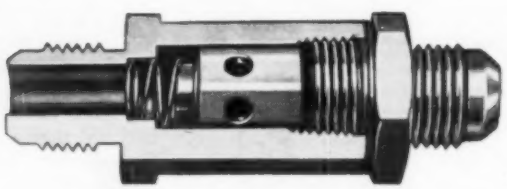

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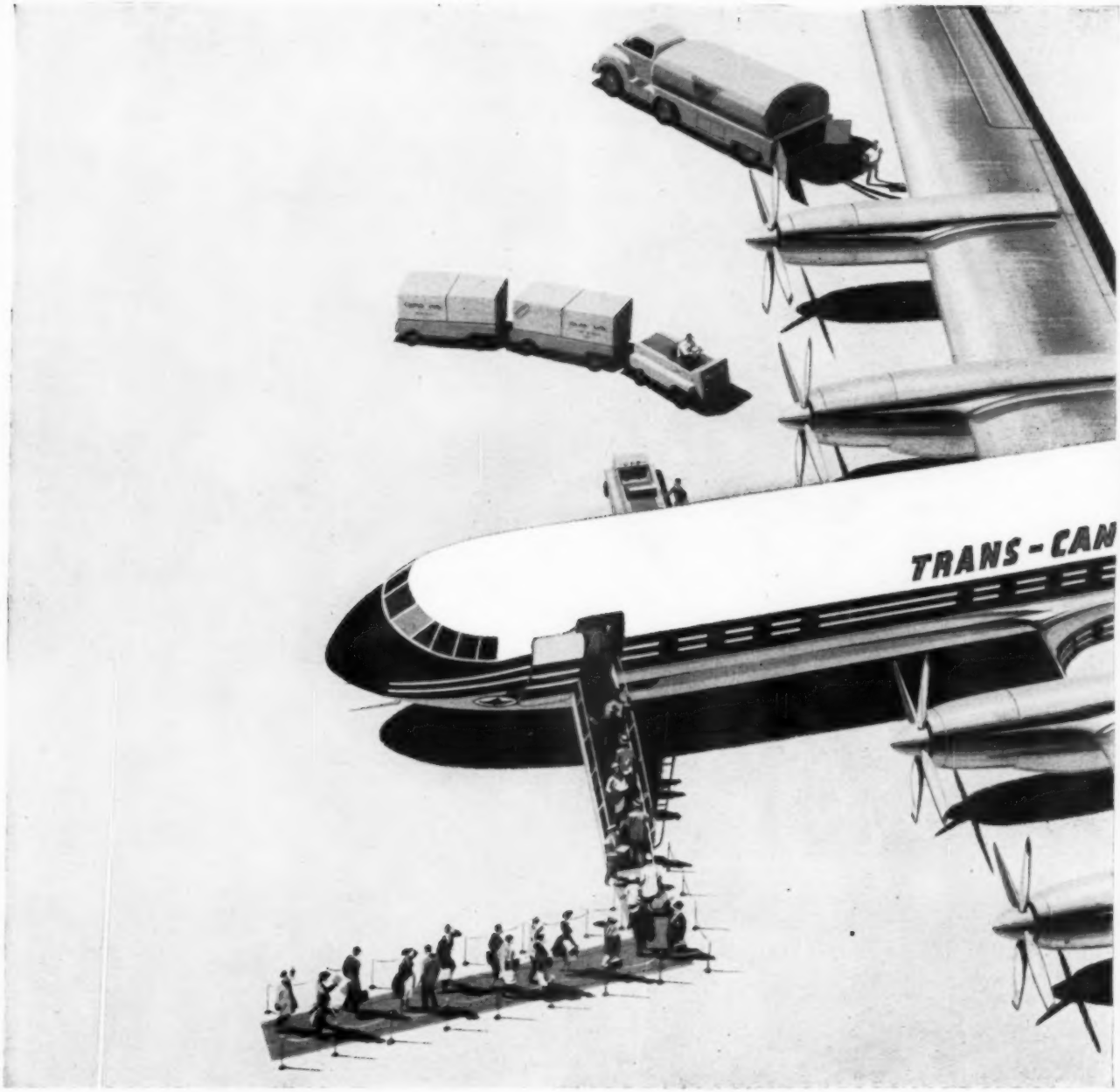
"Our decision to order the Vanguard came after the most exhaustive equipment analysis ever undertaken by the company. The evaluation was made over a period of two years, during which ten other competing aircraft were thoroughly examined."

Here are the seven reasons →



Why TCA chose the jet-prop VANGUARD as its medium-long-range airliner

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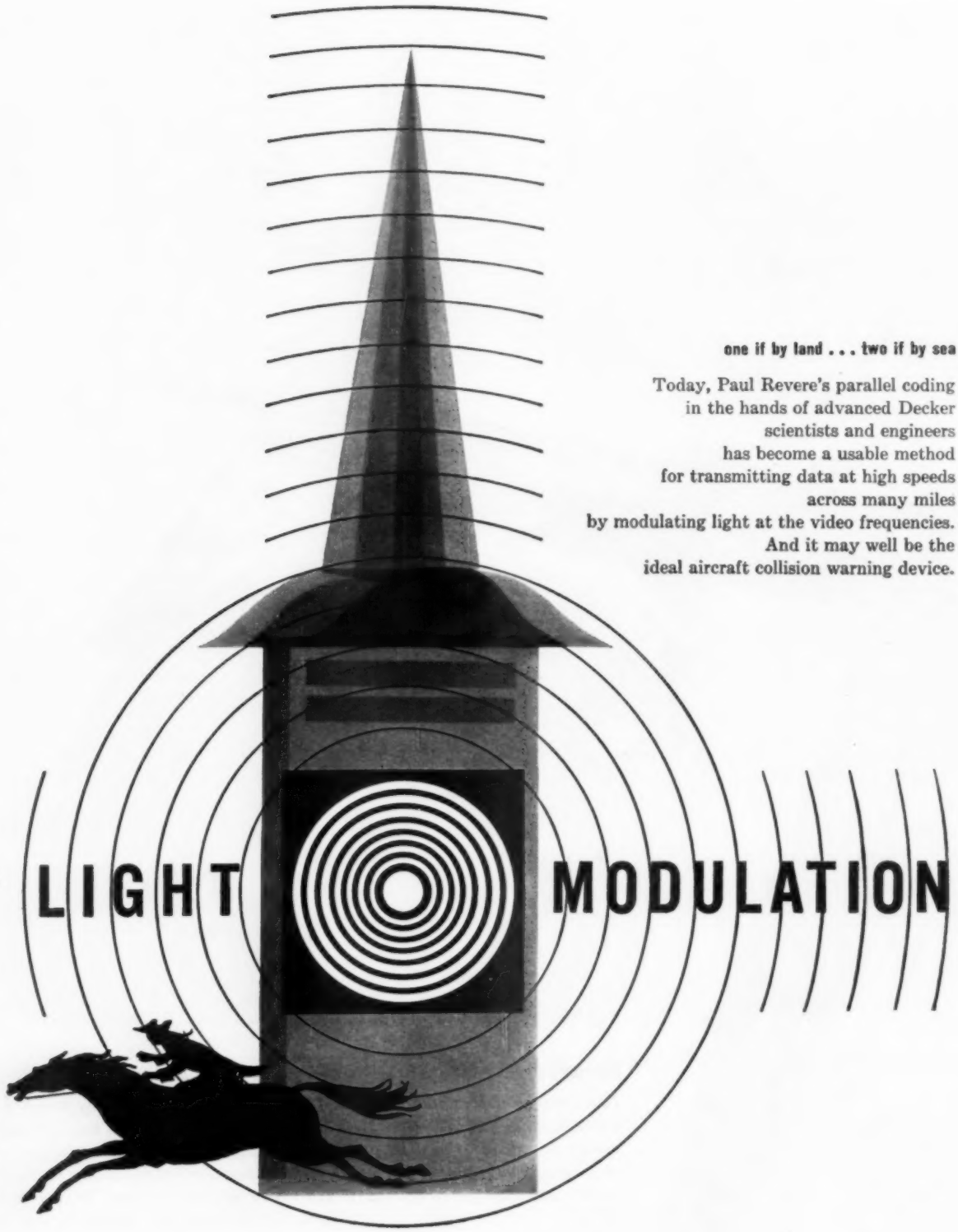

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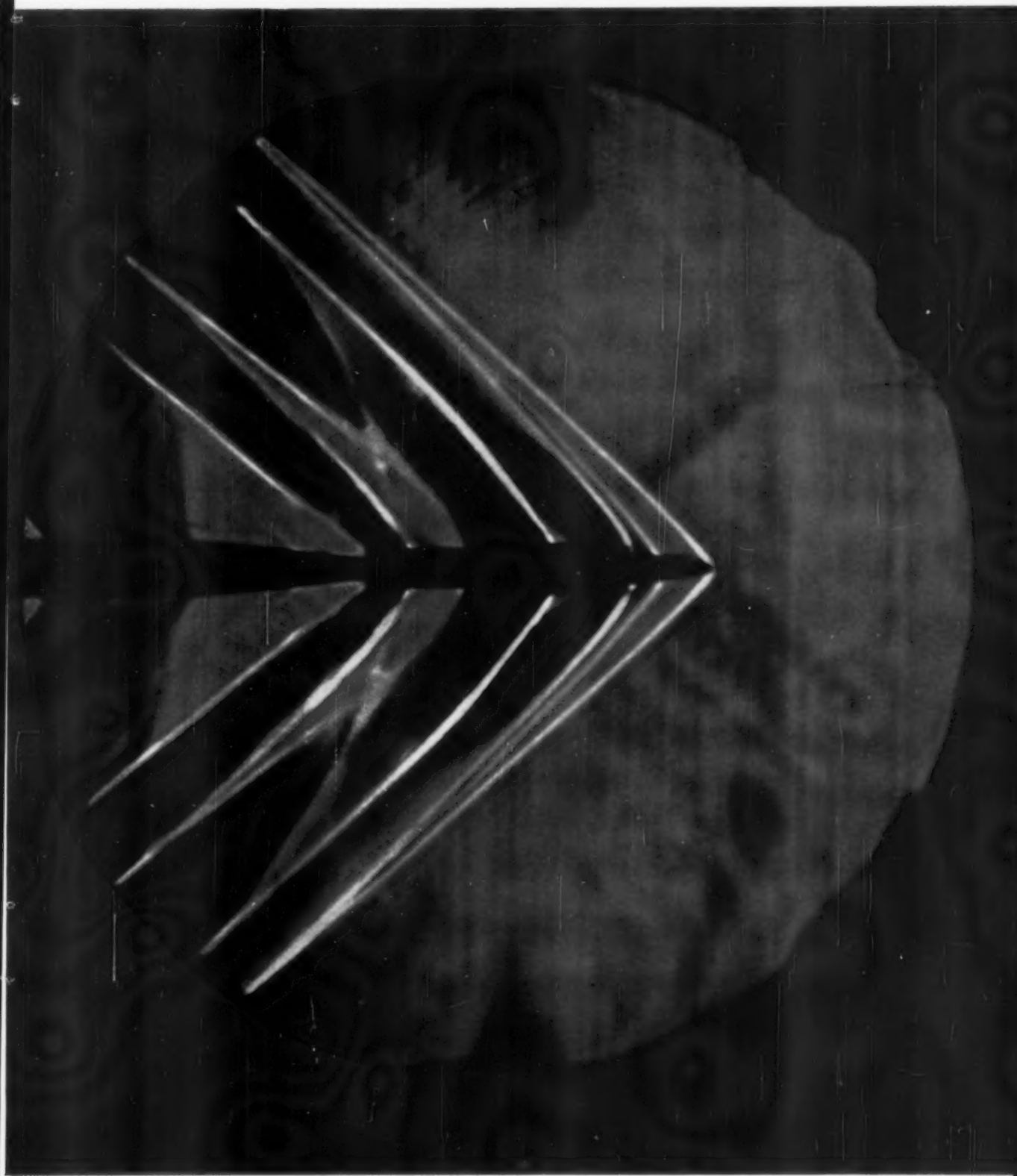

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Power Struggles Affecting Research

Washington—Sputniks and related Soviet gains have brought mixed blessings to military research and development.

The public, Congress, the White House and many others in government now have a greatly increased appreciation of the value of research—and of the absolute necessity for it in the weapons field.

With this appreciation goes a modest increase in the willingness to support research. Fiscal 1959 defense budget calls for $2.256 billion for research and development—an increase of almost half a billion dollars over Fiscal 1958.

When test and evaluation funds are added to this the total reaches $5 billion, about the same as for Fiscal 1958. But basic research, as unpopular in the recent past as the word "space," will be increased about 50% under present plans.

Disruptive Power Struggles

On the negative side, struggles for power are having a disruptive effect on research and development programs in all three services.

Until they are resolved, valuable time will continue to be lost in the critical weapons areas that will determine the nation's strength in the near and long-range future.

None of these struggles is strictly a question of the military versus the civilian point of view.

The main areas of conflict today are:

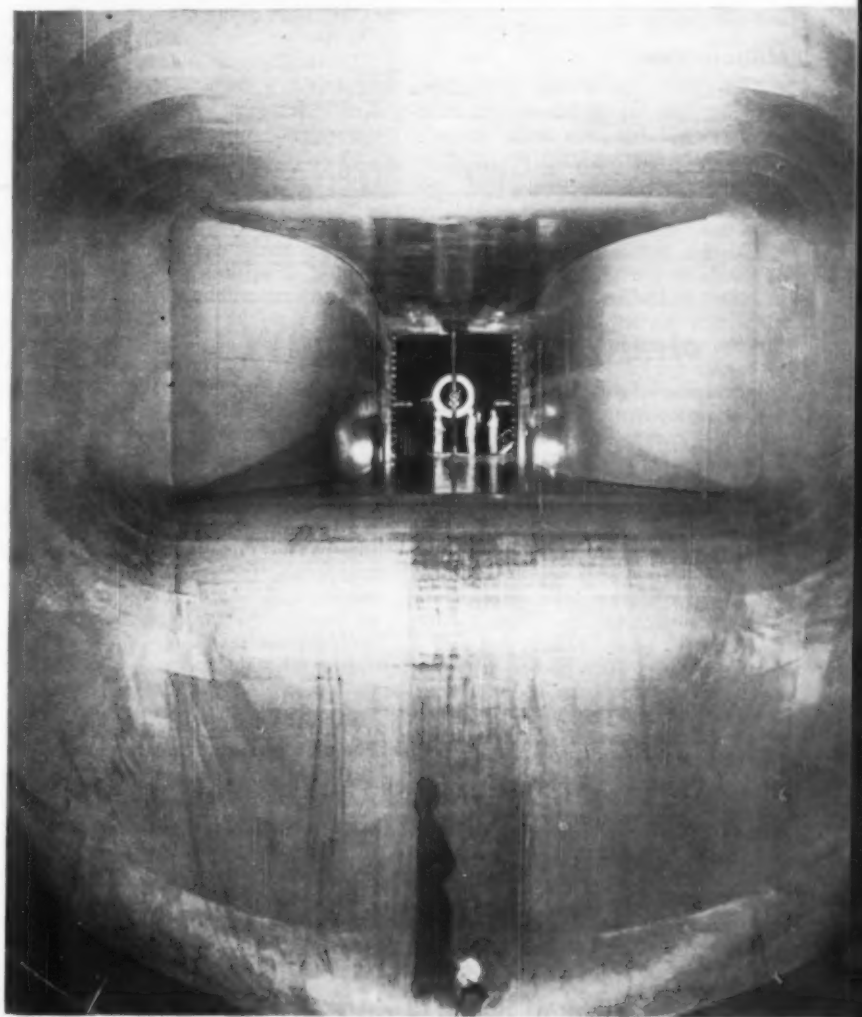
• **Space mission.** USAF Chief of Staff Gen. Thomas D. White has staked a claim to space as the operational domain of the Air Force. Defense Secretary Neil H. McElroy has appeared to recognize and agree with that claim, but he also has said that this could change. Navy and Army also have elaborate plans for space operations and some of McElroy's key advisers have indicated that Defense's new Advanced Research Projects Agency may assign its "upstream" space projects to each of the services as they move out of developmental and into operational areas.

• **Research and development** on military space weapons. All three services have been working in this direction. In addition, the office of William M. Holaday, director of guided missiles, has some control over the military missiles that for some time will provide the stepping stones to space. Now that ARPA has been activated, McElroy speaks of it as "an action agency." He said it was set up to "give the country the needed protection so that we would not miss out on early development of something which might not by some individual service be picked up as some potentially strong weapon system because it might not have any direct tie-in with that particular service."

As for programs already under way, McElroy said ARPA's purpose should be to "provide direction and financing, and not in my judgment to interfere with the actual operation; so in effect what would happen would be that the services would become the agents of ARPA, which would do the planning."

Later, if a problem arose that could not be supported in a service facility ARPA might "set up its own laboratory setups to chase down that particular field of knowledge," McElroy said. "But for the present, it would seem to me that this ought to be a quite high grade—no question about that part—there ought to be a very able group of people in the scientific area who could supply technical planning and direction for these programs and could also be receptive to the new knowledge that is developed in the scientific world and serve as a bridge for the flow, or a channel for the flow of that information into the Department of Defense." This may involve using "quite a lot of consultants," McElroy said.

Despite all the explanations of ARPA's projected role, many in the services, industry and science still eye it with suspicion. Will it be a channel



TRANSONIC test section entrance to 16-ft. square, 40-ft. long propulsion wind tunnel at Arnold Engineering Development Center. Ceiling and floor are fixed. Flexible sidewalls are adjusted by motor-driven jacks to create test velocities up to 1,100 mph. Circular opening above men is front of scavenging scoop.

for the flow of information or another plug in existing channels? Will it spot new areas and weapons possibilities that the services might overlook, or will it be just another box on the organization chart, another step to go through before decisions can be obtained?

• **Research and development** in nonmilitary areas of space technology. There have been almost as many suggestions for attacking this problem as there have been on how to get to the Moon. Some reflect the view, held fairly widely since World War II, that no research and development should be controlled too closely by the services or service-industry combinations if it is to make real progress.

Supporters of this view prefer a new, independent civilian agency, creating new ideas and carrying them to a certain stage of development before they are turned over to the user service or developed into vehicles for scientific and civilian research.

Military View

Military's point of view generally is that a user must do his own development, if not his own basic research, so that planning for other phases of his operation—supply, training, base support—can be geared to new discoveries from the beginning.

For this reason many military men oppose both the ARPA idea within Department of Defense and the suggestion for a new agency outside of Defense. But the opposition is far from the magnitude or the bitterness of the postwar atomic energy fight.

One reason is that the services see a workable compromise. They already have thrown considerable support behind the National Advisory Committee for Aeronautics' proposal that it be the space research agency—as it already is to some degree—and that it work with National Academy of Sciences, National Science Foundation, the services and ARPA, if necessary, on both civilian and military goals. NACA has said it can work with ARPA and McElroy has said: "There would be complete concurrence on our part with the desirability of working with an agency like the NACA because we have carried our share of the load, they have carried a strictly scientific share, and I think that we have contributed to each other's programs in a way which I think is most desirable for this kind of thing to proceed."

Atomic Energy Commission also has been suggested as the civilian and military development agency, because of its experience in developing for both kinds of user in the past and the fact that it is now engaged in research on powerplants for aircraft, rockets and ramjet vehicles.

AEC Chairman Lewis L. Strauss has remained, as one observer said, "noncommittal in favor of this proposal." It also has some support on Capitol Hill, battlefield for the third type of space struggle.

• **Control of the space agency** or agencies. This breaks down into a question of whether the legislative or the executive branch will really call the plays in controlling space agencies, projects, and funds; and of who in Congress shall hold a position of power on space efforts comparable to the positions of power held by current armed services and appropriations committee chairmen.

Senate Majority Leader Lyndon Johnson (D.-Tex.) already has created a 13-man select committee on space. The House will have a standing committee on space. Congress already has made it clear that it intends to have the final word on what agencies play major roles in space vehicle development and exploration, regardless of what the executive branch recommends.

On the executive side, there is the influential voice of Dr. James Rhyne Killian, Jr., President Eisenhower's special assistant for science and technology, who must work with Defense, the rest of the executive branch and all interested committees of Congress.

Secretary McElroy has said that none of these questions, not even the forthcoming reorganization of the Defense Department, will be allowed to slow the country's military efforts. But there is no doubt among Pentagon observers that uncertainty and indecision have so far delayed real acceleration of defense efforts, particularly in the space area.

Certain ground rules must be laid down and certain questions of authority and organization clarified before there is any real success. Continued dispute over the decision to produce both the Jupiter and Thor intermediate ballistic missiles and the decision to have USAF employ both is an example of the kind of trouble that will exist until these problems are solved.

But questions of authority and organization are not the only problems facing research and development.

Fiscal Controls Continue

One is overcoming the inertia caused by tight fiscal controls imposed last year to decrease overall defense spending. This period of slowdown and cutback left defense officials with the conviction that better fiscal management is possible, no matter how many funds become available and how many new projects are begun.

Both civilian and military leaders in Defense Department have said frequently since the tightening up began that the economy program gave them a chance to get rid of unwanted but hard to kill projects, and to cut down and hold down on overhead, surplus facilities, and building of new facilities.

The result is that some fiscal controls will become permanent fixtures, and economy will continue to be the watchword, at least as long as the overspending and budget ceilings of late Fiscal 1957 and early Fiscal 1958 are remembered.

One example is the "Financial Status Report of Contract" now required quarterly from enough contractors so that 80% of any defense appropriation can be accounted for at any time. Stated purpose of the form is to "obtain information on existing contracts and on planned programs on which to base expenditure controls, and to obtain a report of the financial status of certain individual contracts or programs."

This hits basic research contractors particularly hard, especially in the universities, where a science department or an individual researcher now must provide 19 items of information each quarter, including unliquidated commitments and cumulative expenditures, estimated contract completion dates, etc.

Previously, most basic research contracts called only for annual and termination reports, plus "technical notes" whenever significant progress could be reported.

Industry's Research Problems

In the broader picture, any financial problem affecting the aircraft industry critically affects defense research and development. Gen. Orval R. Cook, president of the Aircraft Industries Assoc. pointed out recently why this is so.

Of all the funds being spent on aerial vehicles, at least 85% are contracted to companies covered by AIA. Much of this is passed along to tens of thousands of suppliers and subcontractors.

A good percentage of this is spent on research and development for these vehicles and their components, and the government continually asks companies to invest even more in their own R&D facilities.

"The aircraft industry in the years since World War II has spent $1 billion on research and test facilities and plans to spend another $1 billion in the next five years," Gen. Cook said. "Obviously, this industry cannot continue to maintain such a pace if earnings continue the decline experienced in 1956 and 1957.

"Yet, these facilities and more in the same class are vital if we are to continue to successfully develop new weapons."

Low profit margins and current renegotiation procedures, Cook said, are leaving manufacturers "unable to retain enough earnings to finance their contracts or to provide needed research

facilities"—even though "new research and development responsibilities and new financial requirements (have been) imposed upon them in recent months."

The challenge to industry, universities, non-profit research organizations and government laboratories has never been greater.

E. Finley Carter, director of the Stanford Research Institute, said shortly after the first Russian Sputniks had shocked the country that "perhaps the greatest lessons we can learn from the satellites are not in the physical sciences," but "lessons about ourselves, and about the steps we must take in order to regain our prestige and maintain economic and moral, as well as scientific, leadership."

Sputnik's Lessons

He listed a number of them—shortening decision-making time, speeding up the translation of foreign research documents, getting rid of the not-invented-here complex, increasing the exchange of knowledge with allies, etc.

Then he used a research example to illustrate the public soul-searching that has followed the Soviet satellites.

"Human reactions make interesting study," Carter said. "Corporate organizations can often be used as prototypes to better understand reactions in larger social groups.

"In industry, there are executives who claim to appreciate the importance of research, and who give it lip service, but who often fail to provide the tangible support necessary to cross the threshhold of accomplishment.

"Yet, when a competitor comes out with a new product or a new process, these executives are the first to summon their research people and ask, 'Why did you let this happen?'

". . . In corporations, it usually becomes evident that the fault did not lie entirely with the research people nor entirely with management, but in the failure of both groups to communicate to each other the needs and problems of the future.

"There are elements of this situation in our satellite and missile development, as well."

Carter found some hope in the way the nation was reacting, and said the satellites had "jarred us out of our complacency."

"They have created a national consciousness of the need for greater and more effective scientific research to maintain our posture of military strength, while seeking more effective means of creating peace through mutual understanding.

"Let us learn from our mistakes—not die by them," Carter said. "Let us grasp this opportunity and proceed with the job ahead."

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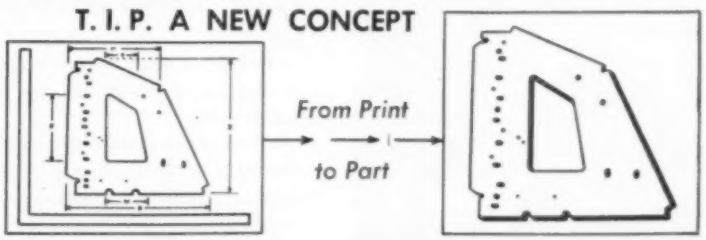

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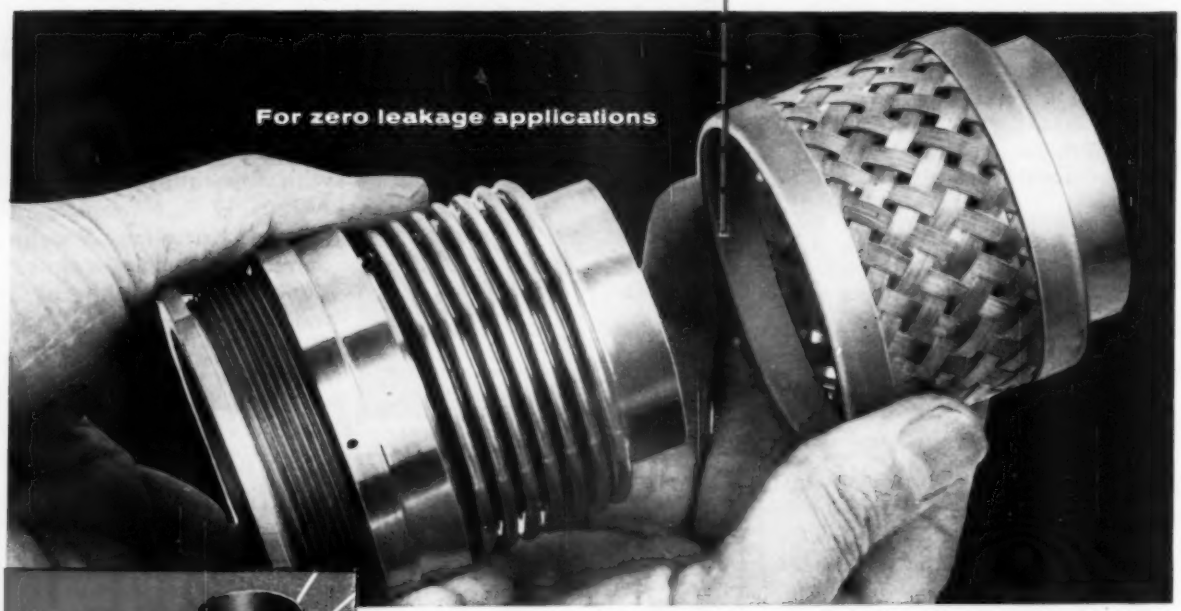

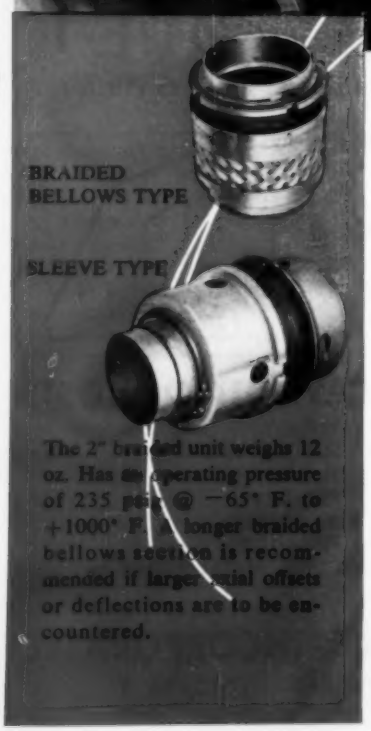

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Materials Hurdle: Speed, Temperature

By Irving Stone

Accelerated research and development for advancing the technologies of ballistic missiles, recoverable satellites and space vehicles, and future high-supersonic military aircraft is placing stringent demands on materials and structures to meet extreme operating conditions.

For the general category of out-of-atmosphere vehicles, effects of high-speed, high-temperature re-entry on nose portions of the body will be the critical factor. Much work remains to be done beyond nose-cone technology already developed.

Similarly, for high-supersonic military planes projected to enter service within the next few years, temperatures generated by sustained high speed flight will be one of the big hurdles.

And for both areas, another vital factor is involved. Practical solution of these materials and structures problems will require new approaches stressing teamwork between specialized skills, which formerly exercised relatively independent action in their particular fields.

Now, problem solutions will require closest unified effort between metallurgists, structural designers, chemists, aerodynamicists, thermodynamicists, and manufacturing researchers.

For re-entry bodies, adequate materials coupled with ingenious methods for taking care of high heat encountered will be the controlling factor, rather than specific structural design as in today's conventional applications. Temperatures involved conflict with those of melting points of usable metals, hence materials problem is a severe one.

Five general schemes appear feasible for application to the materials-structures area for accommodating heat removal:

- **Heat sink makeup.**
- **Porous metal construction.**
- **Fusion and/or evaporation** of surface structure.
- **Internal cooling.**
- **Surface functioning** as radiation material.

One of the simplest ways to handle the problem of re-entry is to provide material of sufficient capacity to absorb this heat. This is the heat sink scheme and its use depends on the character of the heat pulse and the thermal properties of the material. There is a distinct difficulty in this approach, because as the severity of the heat pulse is increased it will not be possible to get materials to remove the heat fast enough from the surface to prevent the metal from melting.

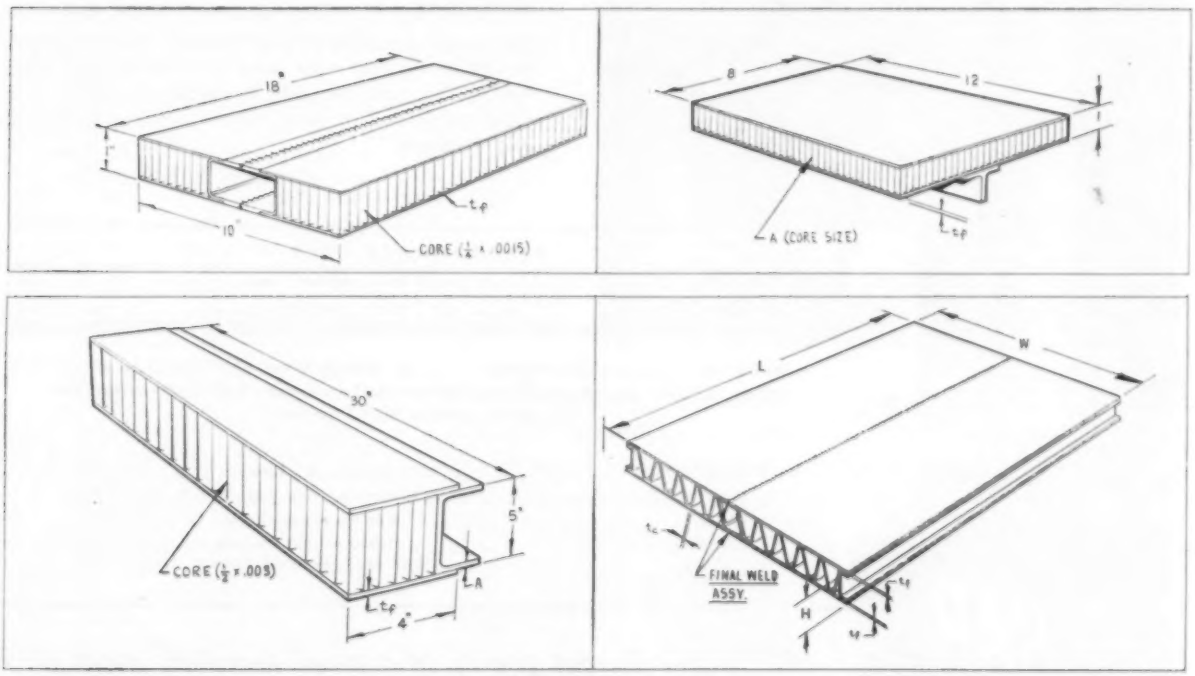
Ideal material for heat sink use would have high conductivity, high heat capacity, high density and high melting point, but nature doesn't supply such a material.

Synthesizing in this field also has definite limits, because it is known that heat sink materials are limited specifically with respect to heat pulse they can take and to conductivity.

Materials with attractive conductivity include copper, tungsten and molybdenum.

Use of these materials to extreme applications would require high drag shapes to insure deceleration at high altitudes, where heat transfer is minimized, so that heat flux will be sufficiently low to prevent the material from melting.

For re-entry body nose application, thicknesses as well as material will be dependent on total heat input to the body. Thus, for ballistic missile nose cone, material will be massive. Instead of skins, slabs of the order of 1 in. to



EXPERIMENTAL North American sandwich panels. Top, left: brazed honeycomb panels are joined by fusion weld at connecting channel members. Right, structural unit has panel attached to cap angle. Bottom, left: brazed honeycomb sandwich with channel-member, edge attachment. Right, resistance-welded sandwich skin panels are fusion-welded at top and bottom skin assembly joints. Panels are being made in various heights and skin-to-core thickness combinations.

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12 in. thick will be used, depending on deceleration, angle of entry, and aerodynamic configuration.

If higher re-entry velocities are involved, as with longer range missiles, difficulties associated with the heat sink approach become more severe, and higher drag shapes are indicated to slow down these missiles. This in turn introduces the undesirable characteristic of rendering the missile more vulnerable to counterattack.

This makes it advisable to look for means to take greater maximum heat rate as well as total integrated heat. One scheme is to use porous material and utilize the sweat cooling principle—ejecting coolant for evaporation (perhaps water, because it takes considerable heat to vaporize one gram).

Materials

Two general types of materials seem feasible here. One is the sintered wire mesh which allows control over total porosity, size of pores and direction of porosity. Experimental nose cones varying from 4 to 20 in. in diameter, have been made from Poroloy, a sintered woven wire mesh material manufactured by Poroloy Equipment Inc., a subsidiary of Bendix Aviation Corp.

Another porous material is that which can be derived from powder metallurgy. Powder metal is compacted with a binder at high pressures, then sintered in a furnace so that the binder breaks down and escapes as a gas, leaving a porous metal. Powder metals under consideration include stainless steel and copper, and binder material might be ammonium carbonate.

Utilization of heat of fusion and/or vaporization of materials is another approach to the solution of the re-entry problem. In the simplest scheme it may only be possible to use the heat of fusion, in which the material melts and begins to run back along the body. Carrying this further, better efficiency would be realized if it were possible to vaporize the liquid film before it leaves the body. If these approaches were used it would be desirable to utilize materials which have a high heat of fusion (such as ice, if it were possible to use it).

It will be difficult to use a metal which is satisfactory in relation to pure fusion technique, since metals are crystalline materials, have sharply defined melting points. Molten metals are very fluid and would tend to run off the body immediately.

Desirable materials therefore would include those with higher viscosity and surface tension, to give "goopy" effect. Lower melting point ceramics might be usable. Higher melting point ceramics might decompose and break apart.

Internal cooling is another possibility for protecting surface materials by cooling the back of the surface. In effect

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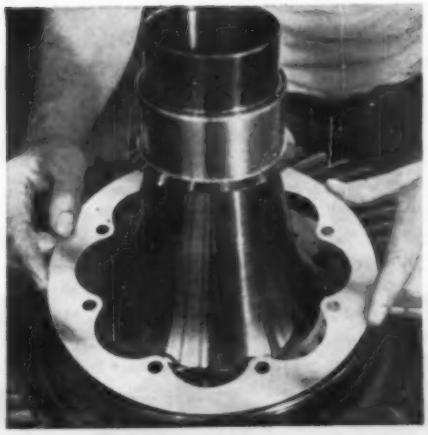

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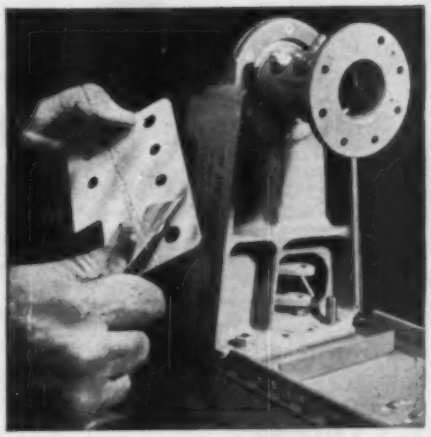

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this method of cooling is essentially a heat sink scheme with increased capacity provided by the coolant.

Surface materials might be stainless steel or other high heat alloys. Coolant might be water or some other suitable fluid.

Essentially, internal cooling is a design problem, involving more complication than that associated with change of phase (fusion and vaporization) techniques, which are self-regulating. With internal cooling (and porous cooling as well) rate of coolant flow must be programmed to correspond with the heat input.

In contrast to the heat sink, porous metal, internal cooling, and change-of-phase techniques, which are for transient conditions, radiation cooling would be applicable for steady state conditions such as for a vehicle engaged in sustained hypersonic flight measured in hours instead of minutes.

If "q" input (steady state heat rate) is less than the rate the body is capable of radiating at the melting point, the radiation technique is possible.

High Temp

Materials suitable for this mission would require a high emissivility and high melting point, and include stainless steel, Hastelloy, high chromium content metals, and other high temperature materials now being developed. These materials can be used in relatively thin sheets, in contrast to heat sink material thicknesses, because radiation is a surface property and heat capacity in this technique is not an essential characteristic.

Promising construction for radiation scheme is honeycomb sandwich where the core becomes an additional radiator of high effectiveness.

It may also be desirable to back up the surface material with an insulator, thickness of which would be dependent on operating temperature of the surface material. Low thermal conductivity would be a desirable characteristic for the insulator, and materials such as thoria and alumina may emerge as typical backup insulators.

Associated with techniques involving materials subjected to high heat flux rates are difficulties stemming from chemical interaction between hot atmospheric constitutents and surface materials. Conditions surrounding this chemical interaction are different from those encountered in laboratories or in past industry experience, and when burning or reaction occurs it does not happen in the conventional sense.

This means that evaluation of any materials for advance flight regimes must also include an aerothermalchemical analysis. This involves consideration of aerodynamic flow thermodynamic properties of atmospheric constituents

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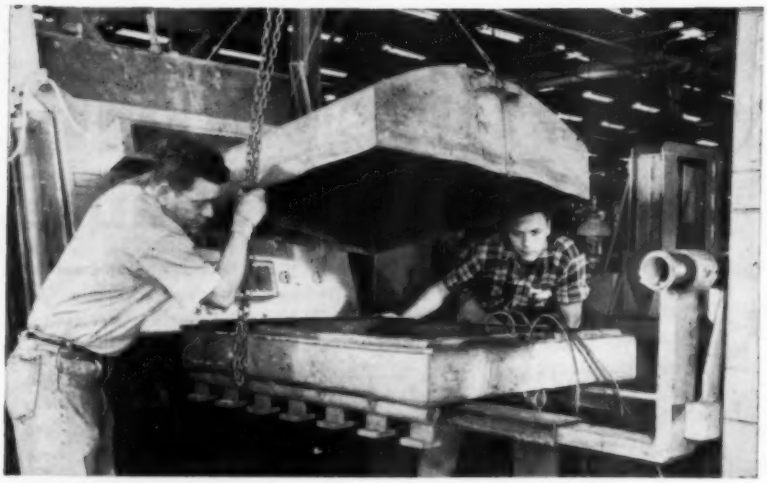

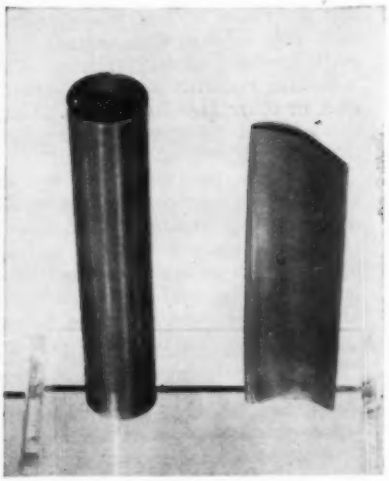

EXPERIMENTAL furnace brazing procedure (left) at North American Aviation uses outer retort to enclose inner retort which contains sandwich panels being brazed. Right, turbine blade made from tube of Poroloy sintered wire mesh for air cooling.

and the surface material, and the physical-chemical interactions between atmospheric constituents and surface materials.

Relatively still in a state of infancy, aerothermalchemistry has progressed to the point where laboratory experiments have demonstrated principles and provided data for sound design. Future applications of aerothermalchemistry will be definitely related to the general regime associated with ballistic missile refinement involving higher speeds, long ranges and shallower re-entry angles, as well as with satellites and space craft.

One company which has been actively engaged in devising methods and materials for coping with high heat flux environment associated with hypersonic re-entry conditions is Aeronutronic Systems, Inc., Glendale, Calif. It has made exhaustive studies of all the heat handling schemes and now is exploiting one of these approaches, under contact, with a probability of early development. Aeronutronic personnel associated with this research and development include Dr. Joseph Charyk, director of ASI's Aeronautic Laboratory; Dr. D. A. Dooley, head of Missiles Analysis Sec-

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tion; and Dr. D. Altman, Manager, Propulsion Department.

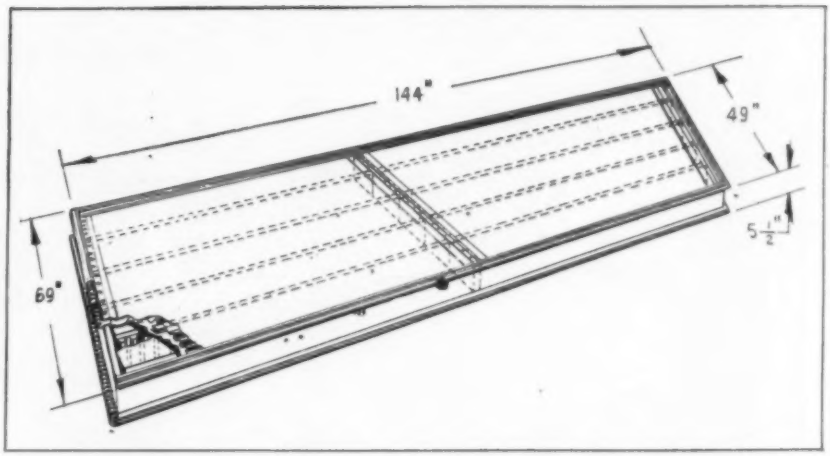
Engine development for out-of-atmosphere travel also will be a fertile field for proving of methods and materials associated with handling high heat conditions. Extended out-of-atmosphere missions will call for higher performance propellants with flame temperatures exceeding 6,000 F.

This means that rocket people will be working in a common area with those engaged on re-entry problems, since rocket temperatures will be approaching those associated with re-entry conditions. As re-entry problems are solved, propulsion people will be able to draw upon results to design engines for appreciably higher specific impulses.

Two parallel areas associated with re-entry and rocket engine development include the heat sink and internal cooling. Heat sink technique is similar to that often used for solid propellant nozzles, where burning time is relatively short and surface heat input is absorbed in the material mass. Internal cooling is similar to regenerative cooling in the case of the rocket.

One of the materials being considered in the manufacture of rocket engines containing porous liners and nozzle sections is Poroloy, sintered woven wire mesh for transpiration cooling. This porous metal arrangement is also being considered as a nozzle material in plasma jet devices. In other applications, Poroloy is being investigated for use as an air-cooled porous turbine blade shell and as turbojet combustion chamber liner.

To cope with temperature levels below that of general re-entry conditions, work is being pushed on materials and structures for future aircraft projected to operate at Mach 3 or better in sustained flight. Temperatures expected to be encountered in external and internal structure are in the 800-900F region. Materials in the picture include the semi-austenitic PH stainless steels, hot-work die steels such as H-11 type tool steels, and new titanium alloys such as 6Al4V, 4Al3MoIV, and 16V2.5Al, now being developed under Dept. of



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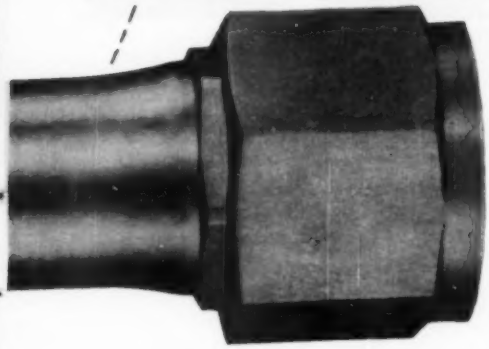

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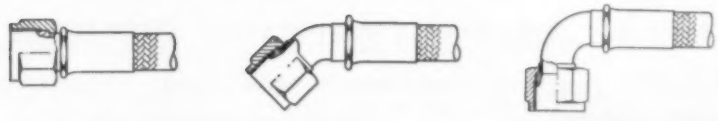

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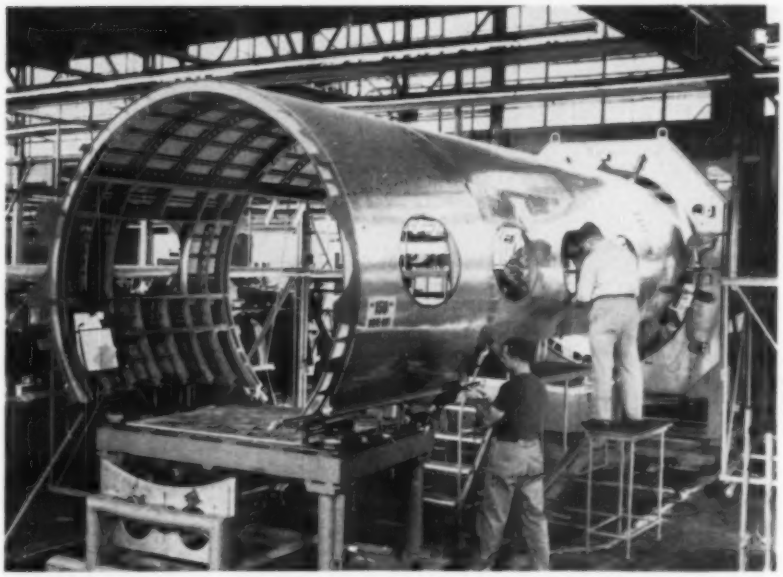
Defense's titanium alloy sheet rolling programs.

One of the companies deep in the work of evaluating these steels and alloys is North American Aviation, Inc., which is investigating properties, fabricability and reproducibility. Heavy emphasis is being placed on research and development to prepare these metals for production design and fabrication. In addition to being harder to work, these materials probably will appear in structural forms different from those used in conventional practice.

Bulk of materials will be in flat-rolled form, including light-gage plate, sheet, strip and foil. Emphasis also will be placed on extrusions because of the great flexibility of shapes available in this form, which permits more efficient design, plus the savings available in reducing machining time. Emphasis will also be placed on zero-draft forgings.

Tolerances

Big problem in the high-temperature flat-rolled products will be to obtain the material in sufficient widths and lengths desired flatness, and close gage tolerances. Latter two requirements are very important because manufacturing researchers declare that there is no point in specifying very close tolerances for assembly and detail parts if raw material tolerances in flatness and gage exceed allowable variations for fitup. Also, over-tolerance in steel and titanium alloys means more dead weight than in an aluminum alloy structure.



FUSELAGE of turboprop powered Grumman Gulfstream business plane takes shape at company's Bethpage, Long Island, plant. First flight is scheduled soon.

Air Force interests in the raw material problem is very keen now. It has asked industry to report on future requirements and, with this information, it will determine if and to what extent government support will be needed to obtain material forms in sizes, gage and conditions required.

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Mach 3 and above is that the high-temperature materials of construction will permit use of fusion welding as an assembly procedure instead of joining by mechanical fasteners. This fusion welding technique will be applicable to components such as fuselage sections as distinguished from structural detail parts which also could use welding and brazing in their makeup and which could be attached to main structure by resistance welding.

According to Robert Kostoch, NAA's Material and Process Group Leader, fusion weld inspection standards will have to be developed specifically for aircraft assembly applications. Big factor will be quality control, which will be essential to develop economical acceptance levels and economical and fast inspection techniques for structural components. Because semi-austenitic stainless steels and titanium alloys will be used in welded assemblies and sandwich type of construction, in-process quality control becomes a prime factor. Inspection after assembly or part completion will be less feasible than in today's conventional riveted aluminum alloy structures.

Structural makeup of the very high-speed plane will emphasize heavily honeycomb and/or corrugation all-metal sandwich construction to a much greater extent than in use today. In general, the high-temperature steels and titanium alloys will lend themselves to both brazing and resistance-welding techniques.

Key Factors

According to Gordon Fairbairn, supervisor of metals in Kostoch's Materials and Process Group, important factors will be:

- **Detail design** of the sandwich to permit efficient unloading will make critical the design of such items as inserts and edge attachments.
- **Reproducible product,** as distinguished from laboratory product, will have to be achieved.
- **Tolerances of brazed** or resistance-welded detail parts will have to be held to a finer degree than on conventional structures.
- **Heat treatment** will involve problem of compatibility of the brazing cycle with heat-treat cycle.
- **Development of brazing** materials and equipment will be big factor. This includes heating media and tooling such as positioning, handling, and straightening fixtures. Brazing materials will have to be compatible corrosion-wise with materials being brazed.
- **Development of resistance-welding** techniques and equipment will require considerable exploration.
- **Avoidance of warpage** will be problem during the heat-treat cycle following

brazing and during the welding cycle itself.

• **Inspection of detail** structural parts to insure good bond between brazed or resistance-welded components.

• **Methods will have** to be devised to facilitate factory and field repair of brazed or resistance-welded components.

Many other materials are being studied for specific applications for future high-speed combat aircraft:

• **Ceramics are being investigated** as a coating material for heat- and oxidation-resistance and thermal insulation service. Ceramics also might be adapted to electrical systems as insulators, for high-temperature bearings, radomes and antenna windows.

• **Powder metallurgy products** are being evaluated as bearing material impregnated for lubricity.

• **Sintered wire mesh** for transpiration cooling of surfaces is being studied for high temperature applications. Poroloy, for example, can be made with a pore which slopes at an angle to the surface of the metal to introduce cooling air in a direction approximately parallel to that of the slipstream, thus creating minimum turbulence and heat transfer.

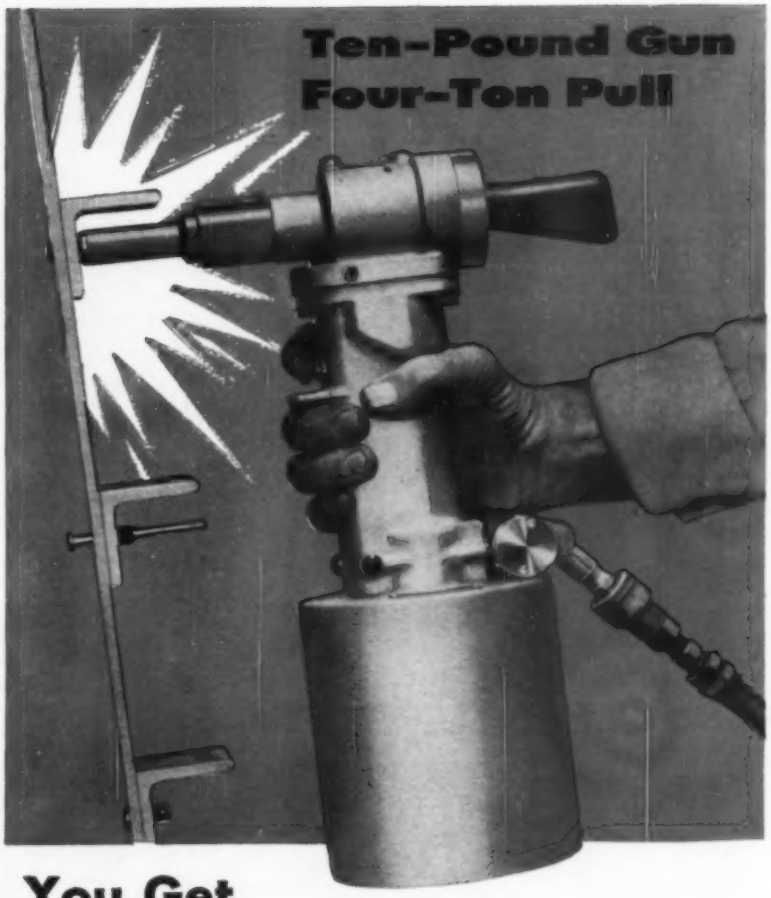
• **High temperature finishes,** such as platings and inorganic coatings also are under evaluation for critical jobs. These finishes will be required for protection against corrosion, erosion and heat oxidation, and for desired reflectivity and emissivity characteristics of both external and internal surfaces, Fairbairn says.

• **Beryllium is looked upon** as a very attractive material for future high-speed, high-temperature aircraft, but present development of ductile beryllium alloys in product forms is not considered sufficiently advanced by structural researchers to warrant use as a general structural engineering material.

Specific Uses

Nevertheless, NAA is considering the metal for specific applications where its lightweight, high stiffness, high specific heat and corrosion-resistance would specially fit. Possibilities include heat sink application, such as behind leading edge of wing to quickly dissipate heat buildup on surface and for fairing material over external controls where stiffness, rather than strength, is important.

Environmental problems associated with metals in general will be a critical factor in future high-supersonic aircraft, since specific information in this area is not completely available. Factors which will require considerable study include effects of temperature, exposure to specific chemicals such as exotic fuels, and nuclear radiation. Another prime area will be research on environmental relationship to stress-corrosion and fatigue life of metals used at high-strength levels.



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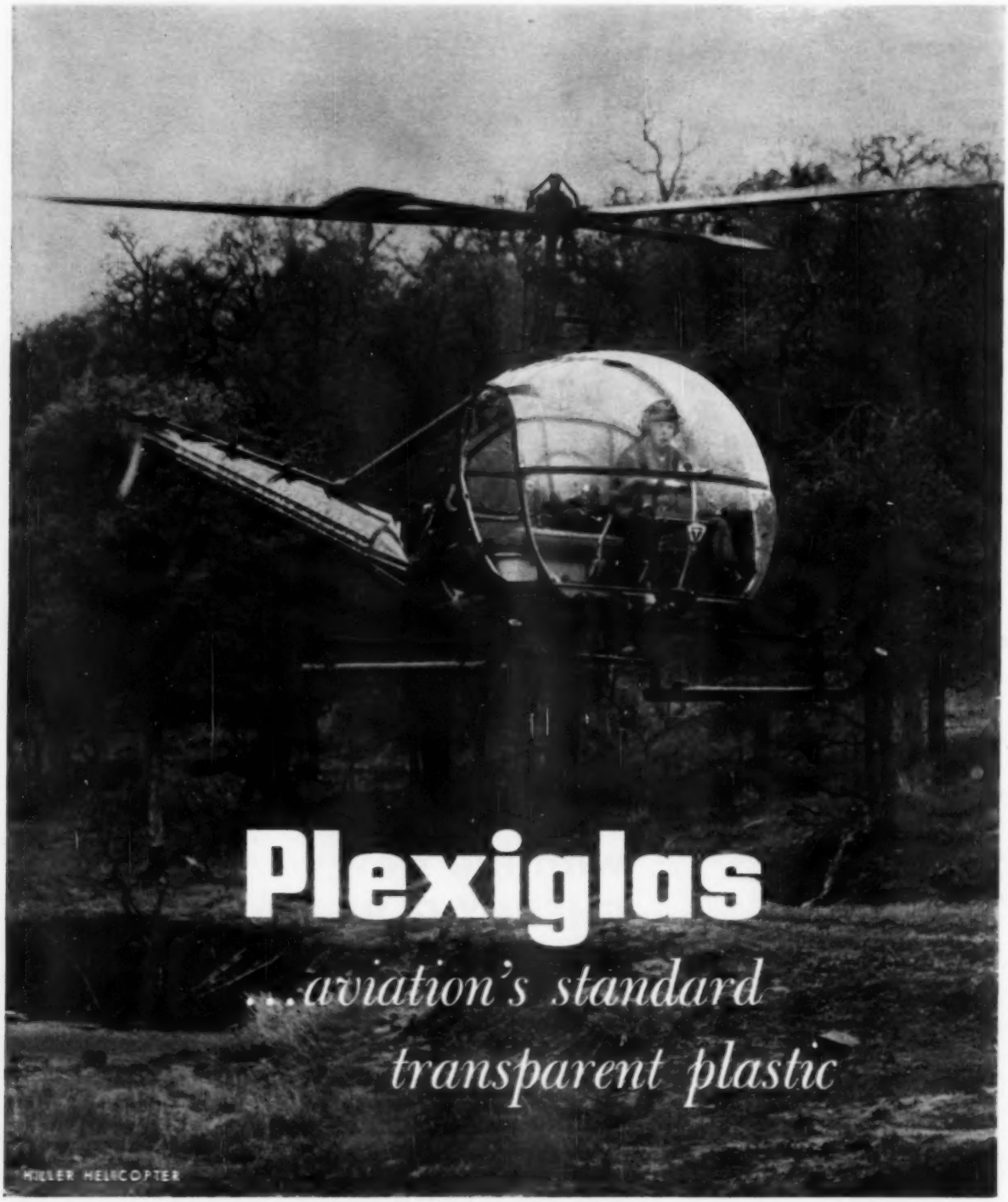

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Reliability Key to Propulsion Problems

By J. S. Butz, Jr.

New York—Now that rocket engine systems have enough thrust to initiate space travel by pushing manned vehicles to orbital speeds, several urgent tasks lie immediately ahead for the propulsion industry.

It must create:

- **More reliable liquid** fuel rockets and more controllable solid rockets to give manned vehicles a better chance of completing a given mission.
- **Very high speed** air-breathing engines so that rocket powered boost-glide aircraft and flight paths are not the only type available at high Mach numbers.
- **Low-thrust, high** specific impulse propulsion systems for economical space travel.
- **High energy fuels** to increase the payload and range of missiles and aircraft to lower the cost of orbital resupply and flight at high supersonic speeds.

The relative merits of solid and liquid fuel rocket engines have become the center of a great controversy which spread last year from the engineering conference table through the technical press and into publications with general readership. This method of airing technical differences probably will be repeated many times in the near future as long as public interest in rockets does not wane.

Reliability

Most important point in the controversy is reliability. Liquid fuel engines in the development stage have been on public view at Cape Canaveral for many months and their demonstrated reliability has not been high.

However, it is claimed that operational liquid rockets such as the Redstone's engine have a reliability of better than 90%.

New capsulated methods of fueling liquid rockets will cut their long ready time and make them more competitive with solids in that respect.

Solid fuel rockets which require practically zero time to be readied for firing have exhibited a reliability of more than 95% in large scale use. In many applications the solid engine provides superior performance, according to their backers, because the empty weight of the engine is very small as compared to the take-off weight. This superior weight efficiency more than makes up for the somewhat lower specific impulse of the solid propellants if the engine weight is a large percentage of the total missile weight.

In answer to this argument, liquid fuel advocates say that the mechanisms needed to control the direction of the solid rocket exhaust and the engine thrust add enough weight to the engine to eliminate its high weight efficiency. Also these mechanisms reduce the overall reliability of the solid fuel engine and bring it into line with liquid propellant engines, according to some engineers.

Most impartial or objective observers feel that each type of rocket engine has a definite superiority for certain applications.

Overall statements about these applications are not possible as both types of engines are being improved at a rapid rate.

Air-breathing, turbojet engines are now in operational use above Mach 2, a speed that was considered impossible for them less than 10 years ago. Today engine manufacturers say that developing Mach 4 turbojets would be no more difficult than designing the Mach 2 engines.

The past year ended with the manufacturers fearing that the government would not contract for large turbojets capable of Mach 4 or 5.

In all probability such engines would be a combination turbo and ramjet. At speeds around Mach 3 when compressors stop contributing to engine power the rotating parts of the engine would be bypassed and the afterburner alone would function. Main advantage attributed to such engines is that they would provide sustained power over the whole speed range of an aircraft. They

JET ENGINE is tested in propulsion wind tunnel at Arnold Engineering Development Center. Perforations in walls, floor and ceiling permit removal of boundary layer flow to plenum chamber around test section; eliminate reflection of shockwaves. Portion of scavenging scoop is downstream from tailpipe, lower right.

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would not require boosting to flight speed as a ramjet would and they would provide power for landing and greater high speed maneuverability.

The General Electric Company strongly suggested another use for such engines. G.E. proposed them as power for a recoverable first stage for ballistic missiles. In this manner total weight of the missile would be reduced because the oxidizer supply would come from the air. Also, the first stage would be radio controlled and could be brought back to the launching site after carrying the missile to Mach 5 or so and an altitude of about 100,000 ft. The self-transportable nature of the turbojet powered first stage would greatly facilitate missile mobility.

Design Problem

Crucial design problem of very high speed turbojets is to insure that the engines will provide rapid acceleration for an aircraft or missile up to cruise speed. If acceleration is not good the required fuel supply and vehicle size and weight goes up rapidly. Efficient inlet and exit nozzle performance from about Mach 1 to Mach 3 is essential to high thrust and good vehicle acceleration. Variable geometry inlets and nozzles will be used to obtain the required performance.

Ramjets are the only air-breathing engines receiving serious consideration to provide continuous power above Mach 4. Ramjet cycle of the turboramjet is in this category. The National Advisory Committee for Aeronautics work on engines using ram compression is typical of the U.S. effort. The NACA is studying ramjet performance from 2,700 to 4,600 mph.

Two outstanding problems remain for ramjet designers:

- **Cooling engine parts.**
- **Obtaining useful thrust** from fuel energy at very high speeds (above 6,300 mph).

Cooling

Above 3,000 mph. the temperature in the combustion chamber of a ramjet is about 5,000 deg., which is above the melting temperature of most usable metals today. Apparently the most promising method of keeping the inside of the ramjet cool enough to remain structurally sound is to use regenerative cooling. The ramjet would have double walls and the fuel would be circulated in this hollow wall as a coolant before it was burned.

Burning fuel in the combustion chamber at speeds above 6,300 mph. does not raise the temperature of the air passing through the ramjet. At first glance it would seem that the engine would not produce useful thrust above that speed. However, careful design

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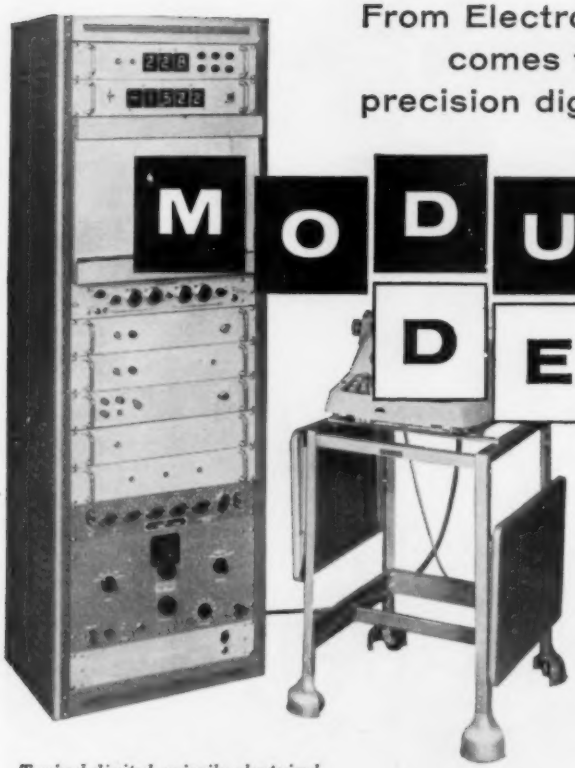

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Display	4 digits, polarity, decimal point	5 digits, polarity, decimal point
Range	.0001-999.9 volts	0.0001-999.99 volts
Accuracy	±1 digit	±(0.01% and 1 digit)
Automatic Features	Polarity, ranging	Polarity, ranging
Controls	Digits gain, manual and automatic ranging, power on-off-standby	Digits gain, manual and automatic ranging, power on-off-standby

Write for Bulletins 180.1 and 180.2

AC-DC DIGITAL VOLTMETERS

Specifications	Model DVA-410	Model DVA-510
DC	Same as DVA-400	Same as DVA-500
AC		
Accuracy	0.1% or 2 digits	0.1% or 2 digits
Frequency Response	30-10,000 cycles	30-10,000 cycles
Range	.0001-999.9 volts	0.0001-999.99 volts
Controls	Same as DVA-400, AC-DC	Same as DVA-500, AC-DC

Write for Bulletins 180.1, 180.2, 180.4

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Automatic Features	Ranging	Ranging
Controls	Digits gain, manual and automatic ranging, power on-off-standby	Digits gain, manual and automatic ranging, power on-off-standby

For accuracy specifications see Bulletin 180.3

Write for Bulletins 180.1, 180.3

AC RATIOMETERS

Specifications	Model DRA-480	Model DRA-490
Display	5 digits	5 digits
Ratio Range	0.0000-1.0999	0.0000-1.0999
Accuracy*	±2 digits	±2 digits
Controls	Digits gain, power on-off-standby	Digits gain, power on-off-standby, reference selector
External Reference	1 volt rms	Choice of 3

*Calibration at 400 cycles; 60 cycle models also available.

Write for Bulletin 180.8

DC RATIOMETERS

Specifications	Model DRC-400	Model DRC-500	Model DVC-400†
Display	4 digits	5 digits	4 digits, polarity
Ratio Range*	.0000-.9999	.00000-.99999	00.01-99.99 volts
Accuracy	±1 digit	±(0.01% and 1 digit)	±1 digit
Controls	Digits gain, power on-off-standby	Digits gain, power on-off-standby	Digits gain, power on-off-standby
External Reference**	1 to 10 volts	10 to 100 volts	±100 volts

*Models DRA-400X and DRA-500L, 10% overscale read out. For higher ratio ranges, see Bulletin 180.7.

†Recommended for computer applications.

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can make the ramjet operate at a higher Mach number.

The reason that burning fuel does not increase the gas temperature is that the gas is already at its dissociation temperature and the fuel energy is used to dissociate the gas molecules into their separate atoms. Development work is being conducted to determine the correct length and geometry for the ramjet tailpipe so that complete recombination of the molecules may occur before the gas leaves the engine and thrust will be produced.

Above Mach 2 dissociation losses get to be a problem and above 5,000 mph. they can amount to a 50% loss in thrust.

Space Engines

A number of quite heavy engines have been proposed by various manufacturers and government agencies to power vehicles that would operate only in space. They would be assembled at some space station in orbit around the Earth. Most of the engines would have very low thrust compared to the large liquid rockets which would take the parts of the space ship from Earth into orbit. They would however have a high specific impulse. Therefore, even though the total weight of such an engine would not be any lower for a given space journey than a chemical rocket engine its resupply requirement for succeeding journeys would be comparatively nil.

For each trip into space the liquid fuel engine would require that more than 80% of its total weight in propellants would have to be brought up from the Earth. The ion engines would need a very small percentage of their weight in fuel, and the total cost of space exploration through a long series of journeys would be substantially lowered.

High energy fuels for rockets and air-breathing engines are receiving considerable development effort in the U.S. Most liquid rocket engine manufacturers are well along with systems using fluorine as an oxidizer and either hydrogen or ammonia as a fuel. These propellant combinations are near the top of the specific impulse list for chemical propellants.

Estimates are being made that full-scale fluorine motors will be well into the flight test stage within two years. Some chemical companies have already built special trucks to transport fluorine by highway and truck load quantities are now being used with experimental engines. Payload weights will rise steeply when these high energy propellants are available and building manned orbital stations will be more practical.

The only high energy fuel nearing the operational stage for air-breathing engines are boron based fuels. Callery

Chemical Company and Olin Mathieson have both built plants to produce a boron fuel that is as easy to handle and non-toxic as gasoline. These fuels will increase the range of today's aircraft about 40%. In new vehicles like North American's WS-110A chemical bomber the greater density of the boron fuel will result in less volume and increased performance for a given range.

Even though construction is under way to prepare plants to produce the new fuel the total estimated production capacity is not large. It would be enough to keep a bomb group of about 30 planes operating. Therefore, it would seem that the boron fuel would probably not be used during all of a given flight.

Also at present it is not possible to use boron fuel in a turbojet because of its solid combustion products which damage turbine blades. They are satisfactory, however, in afterburners and rockets.

The immediate future for nuclear powered aircraft is not very clear. At the moment it looks as though the U.S. program will be accelerated, as certain segments of Congress are said to have rather definite information that Russia is rushing the construction of an atom-powered plane.

Concern among the lawmakers is that Russia will reap another propaganda coup if they are the first to fly such a machine.

Not all U.S. observers who follow Soviet activity closely are in agreement that the Russians are pushing the atomic aircraft.

Some informed opinion indicates that the U.S.S.R. never expends large amounts of money or man-hours on a project that is not virtually certain of success.

This pattern has been followed closely in the past and the large rockets which launched the Sputniks are cited as examples. These rockets were the product of many years of step by step development through smaller rocket projects. The immense effort necessary to design the large rockets was not made until the successful completion of the work was assured.

Security has been eased somewhat around the U.S. atomic plane program and no hint has been given concerning a major discovery in materials or design technique which would indicate that a high performance aircraft can be expected in the near future. The weight problems surrounding the nuclear-powered aircraft are formidable. An atomic submarine, for example, has a power loading (pounds of vehicle weight per horsepower) of about 150 and for a sonic bomber the value must approach 4.

Problem of finding a shielding material light enough for such an aircraft has not been found. Technique of dividing the shielding between the reactor and the crew's quarters cuts down on required shield weight but the crew and the equipment in the aircraft get a sizable radiation dose. This shortens the service life of the aircraft and limits the time that a man can serve around such vehicles.

In view of these problems it is predicted by most segments of the military services and many manufacturers that the only practical atomic aircraft will be a low-powered, low-performance plane with great endurance and usefulness for anti-submarine warfare, radar early warning, etc. Supersonic, high-performance nuclear vehicles will have to wait for lighter, more effective shielding materials.

USAF made a significant decision during 1957 concerning the type of atomic engine to develop for aircraft. The open cycle engine, which heats the intake air by passing it directly around the reactor, was continued while development of the closed cycle engine was essentially dropped. The closed cycle type uses an intermediate heat exchanger and a liquid metal such as sodium to heat the intake air.

General Electric is working on the open cycle and Pratt & Whitney on the closed. The Atomic Energy Commission is continuing to support Pratt & Whitney's project.

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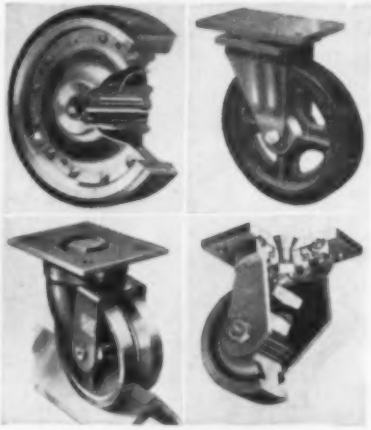

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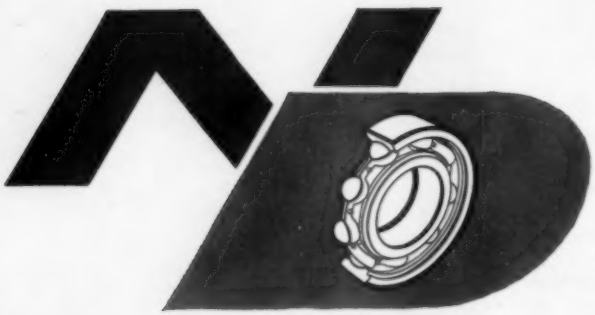

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Human Factors Geared to Space Flight

By Russell Hawkes

Progress of the young science of human factors in flight can be measured by the growing proportion of research into behavioral aspects as studies of the more purely physiological problems begin to bear fruit in engineering and development work. The apparent shift in emphasis has been accompanied by rapid expansion throughout the field.

Much of the credit for these trends must be assigned to Sputnik and another share must go to industry leadership for accepting the human factors approach. The Soviet achievement was unmistakable evidence that men will inhabit vessels in space in the not-too-distant future. It also impressed the general public with the lagging pace of our own efforts in this direction.

Industry acceptance, at first hesitant, is now so complete that nearly every engineering department has its human factors group. A professional association known as the Human Factors Society of America has been formed and in the first three months of its existence, its membership passed 200.

The certainty of space flight and the public support now available for it is drawing much of the advanced research effort in this direction. Most experts in the field no longer regard survival in the hostile environment of space as a critical problem—at least for flight durations up to several days.

XMC-2 full pressure suit is worn during weightlessness experiment.

Cosmic Radiation

The danger of cosmic radiation has been downgraded on the basis of data gathered in upper atmosphere rocket explorations and the Man High II balloon flight of USAF's Dave Simons. Much of Dr. Simons' 32-hour flight was spent at altitudes in the vicinity of 102,000 ft. with only about 1% of the atmosphere's mass to shield him from a respectable cosmic bombardment. The radiation count indicated that even without the scanty shield, it would take something like 2,000 years to accumulate an Atomic Energy Commission career dosage.

The task of designing a canned, survivable environment has largely been completed by the Navy in its development program for nuclear powered submarines. The air regeneration systems of the Man High balloon gondolas embody some of the Navy solutions. Temperature control does not seem too difficult since the space vessel should absorb heat on the sunlit side about as fast as it radiates it on the dark side.

While estimates of the chance of survival are generally optimistic, there is more controversy as to whether man can function properly in space. USAF, which has top authority on all announced programs, says yes, insisting that no man-made equipment can supply the same capability for equal weight.

Man is a reliable sensor for a variety of inputs. The sensitivity of his eyes and ears are close to theoretical limits for resolution of a physical system. With illumination in the radiation spectrum from 4,000 to 7,000 angstroms, he can see form and color and is seldom deceived by unusual perspective. The rods and cones of the retina may react to less than five quanta of energy. The most intense visual signal he can receive is about 100 million times as great as the least intense. His eye can detect an object which subtends a visual angle of as little as one-half second of arc. This means that under ideal conditions it would be possible to see something with a diameter of ⅛ in. at a distance of a half mile.

The energy in the smallest perceptible sound is only slightly greater than that released by the random collision of air molecules. The energy in sound at the threshold of pain is 10 trillion times greater. However, the frequency range of perceptible sound is only from about 20 to 20,000 cps.

As a computer man has the advantage of a good memory for generalized experience and the disadvantage of a very poor one for recent sensory inputs. The human brain with its nine billion binary elements has a very slow access time compared to that of most man-made computers but its ability to draw generalized patterns from previous experience for comparison with the immediate situation makes it exceptionally good at relative evaluations. Since this process of filling up storage elements with new patterns and improving old ones precedes the statement of the problem, man has a dis-

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tinct edge in the solution of unforeseen problems and he does his own coding.

Man can be taught to handle numbers but his time constants are too long to compete with man-made equipment.

Man's muscles are versatile reciprocating motors with truly remarkable fuel economy but their power output is low and their response times are long. The back and legs can provide several hundred pounds of force briefly when properly applied and the arms are capable of bursts of over 50 lb. However, fine control is impossible at these levels.

The fingers provide smaller time constants than any other motor organs in the body and even these are quite slow. In highly developed skills such as typing, the maximum output rate is only about 25 bits per second, corresponding to five or six letters. To capitalize on the relatively high response rate of the fingers, a number of test aircraft have been fitted with little "fountain pen" control sticks and early results look promising.

Man-Jamming

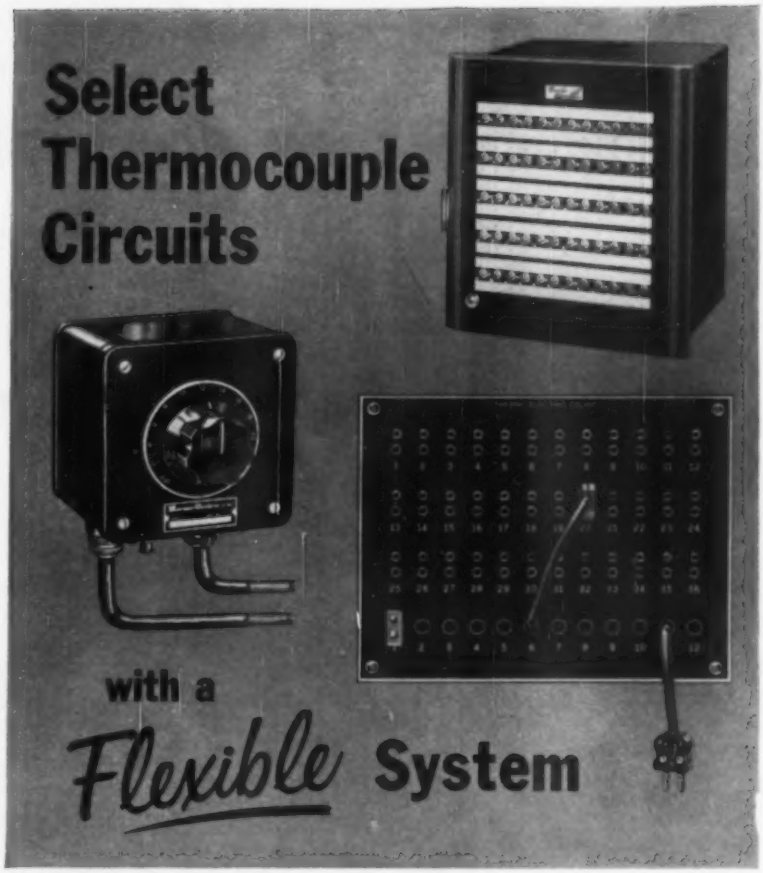
Unfortunately, all of man's actions are subject to a variety of interference and jamming. Fatigue, anxiety, physical ills, overwhelming sensory stimuli and the negative transfer of past learning in which similarities are more apparent than real: all are in the category of "noise." At present there is no objective way of estimating the performance decrement caused by these factors.

The problem of measuring them and getting a good correlation between cause and effect plays a large part in the thinking of the many researchers now going into the question of human behavior in flight.

In Man High II, David Simons undoubtedly had a better opportunity than anyone else has had of making a subjective estimate of the effects upon human performance now existing in the totally hostile environment of space. He and his staff at Holloman AFB are now trying to put this estimate on a more orderly and objective basis. What he seeks is a measure of initiative and creative imagination under specific circumstances.

The term he favors for this measure is "creativity index."

With other Air Force experts, he is convinced that cost, isolation from ground-based help and the importance of scientific and military missions in space will demand the utmost capability of the crew. A creativity index, when associated with the factors which influence it, would make it possible to design equipment and plan missions in such a way that the crew would reach the critical point of the flight at the



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peak of their usefulness.

In Simons' opinion, the most important favorable factor will prove to be motivation. If strong enough, it can counterbalance almost any combination of unfavorable influences. It is also probably the most difficult factor to measure precisely. Ignoring the effects of prolonged weightlessness which are still unknown, the strongest unfavorable influence is likely to be anxiety arising from the crew member's knowledge that his survival is completely dependent upon the proper functioning of all of the space vessel's systems.

An allied approach to getting the proper human capability already exists in the form of USAF's qualitative personnel requirements information program. In the past the program has dealt more with ground personnel, but the approach has general applicability. It is run by the Air Force Personnel and Training Research Center of ARDC and has been in existence since 1954. Its aim is to provide a talent potential while Simons' approach is intended to maximize that potential. The QPRI approach includes the setting of personnel selection standards and the development of training techniques. It is already being applied to orbital recon and weapon systems.

QPRI has been used in about 50 weapon systems and has been credited with an appreciable reduction in time required to reach operational status.

X-15 Flight

The North American X-15 is expected to yield much human factors information, especially on the subject of the pilot's ability to control the aircraft at extreme altitudes. It is likely to be very influential in determining how and to what extent the pilot will control an orbital vehicle on re-entry and recovery.

Somewhat similar problems are already being encountered in operational aircraft. Navy pilots flying the Chance Vought F8U report difficulty with attitude control at extreme altitude because the horizon is so low in the field of vision that it makes a poor attitude reference. As a result some pilots say they are on instruments almost continuously regardless of the weather. They are also beginning to suffer from empty field myopia, in which the eyes automatically focus on a point at a distance of about one yard because of the absence of visual references.

F8U operations are producing curious experiences with acceleration. During instrument flight, heavy G loads in turns tend to disorient the pilot. Below a certain value G loads cause a conflict between visual and acceleration cues and there is some variation among pilot reactions. But at very high loads acceleration cues predominate and pilots have difficulty responding to instrument presentations.

Pilot reports such as these are generally regarded as a valuable basis for further design but there has been much difficulty in evaluating them because of the differences in language used to describe similar experiences. Scientists at NACA's Ames Laboratory have suggested a standardized adjective rating system to get better correlation of pilot opinions.

Industry experts feel that the prospects for safe ejection from aircraft at high speeds still are unsatisfactory but that acceptable solutions are in sight as a result of recent engineering and development work. With current equipment, escape is critical at low altitudes or at those above 35,000 ft.

At speeds above 450 kt. less than 50% of ejections are successful.

Problem of cutting windblast and easing deceleration of the pilot after ejection is well on the way to solution, but longer deceleration raises minimum safe escape altitudes. During the past six or seven years, speeds have increased at the rate of 100 to 200 kt. per year, which also increases the time and altitude required to decelerate the escaping pilot. If minimum escape altitude continues to increase linearly with speed, it will be necessary to eject from 200,000 ft. at Mach. 6.

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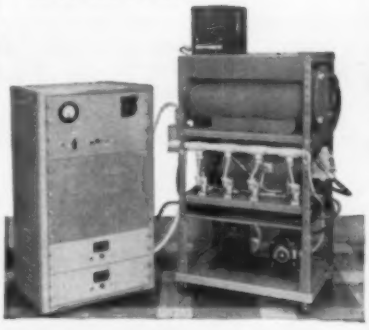

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GYROSCOPES:

Their Strange Properties Changed Our World

Surgically clean, dust-free laboratories are required to produce the highly accurate Sperry gyroscopes for advanced inertial navigation and guidance systems in missiles, aircraft, ships and submarines.

Nearly 50 years ago Elmer Sperry transformed a child's toy into a practical gyro-compass. In a major scientific break-through, man had harnessed the gyroscope's unique ability to maintain the direction of its rotational axis and also its strange behavior when this axis is disturbed.

This historic achievement touched off a series of Sperry developments in gyroscopics which revolutionized marine navigation, gave new horizons to the airplane, and opened the door to outer space. For the marine gyro-compass was soon followed by the first automatic pilot for aircraft and the first guided missile, both introduced by Sperry.

Through the years, new and improved gyro instruments, controls and systems by Sperry became essential equipment aboard ships and planes. By World War II, they had also become essential to our defense. Guiding and stabilizing bombers, fighters, battleships, submarines, tanks and torpedoes, the gyroscope also made possible the first bombsight and the first automatic computing gunsight for ships and aircraft.

The gyroscopes of today—refined, modified and adapted past all resemblance to their ancestors—are widely employed as key elements of precision devices on land, at sea and in the air. In Sperry's modern laboratories unique new gyroscopes are now being developed and produced to meet the challenges of tomorrow.

SPERRY GYROSCOPE COMPANY
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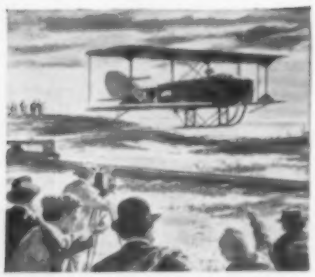
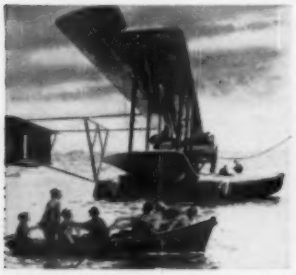
1911 Successful tests aboard U. S. S. DELAWARE proved worth of first Sperry Gyro-Compass in accurate navigation and gunfire control.

1912 Lawrence Sperry, son of the inventor, was first to fly automatically using the first gyroscope controlled Sperry Stabilizer.

1913 First vessel automatically stabilized by Sperry gyroscopes was U. S. destroyer WORDEN.



1915 First U. S. missile was Sperry "Aerial Torpedo", in which gyros held pre-established course.

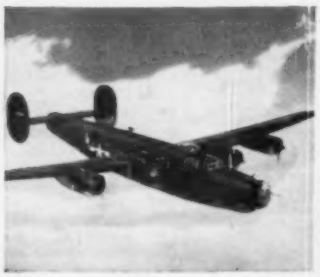


1919 Gyroscopic Turn Indicator and Drift Set guided Navy's NC-4 Flying Boat on first transatlantic flight.

1924 Precise navigation for the first round-the-world flight by Army's Douglas planes was provided by Sperry Master Compasses.

1929 First "blind" flight in covered cockpit by Lt. Jimmy Doolittle using Sperry Gyro-Horizon and Directional Gyro.

1933 Wiley Post's dramatic solo around-the-world flight also won acclaim for Sperry's gyroscopic automatic pilot.



1942 In World War II, Sperry gyroscopes in bombsights and electronic automatic pilots enabled precision bombing.

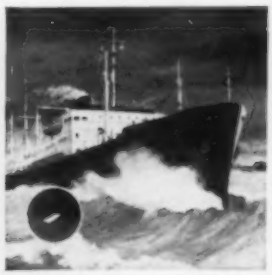
1942 Ship defense against aircraft was greatly strengthened by introduction of Sperry's gyroscopic computing gunsight.

1946 Sperry began design of Sperrow I missile which later became first U. S. operational air-to-air missile.

1952 Improved gyroscopic gunsight helped pilots establish U. S. jet fighter superiority in Korea.

1952 S. S. *United States* keeps on course, on schedule with aid of Sperry Gyro-Compass and automatic steering system.

1953 Navy's Regulus missile, built by Chance-Vought for ship or submarine launching, is directed over great distance to target by Sperry gyroscopic controls.



1956 Sperry Gyrofin™ Stabilizers reduce ship roll up to 90% for passenger comfort and cargo protection.

1956 Advanced Sperry gyroscopes form core of electronic flight control and bombing system for B-52 bombers.

1957 B-58 Hustler, first supersonic jet bomber, has extremely accurate Sperry navigation and guidance system.

1957 Albacore, the sub that "flies" under water, has complete Sperry gyroscopic control system similar to an airplane's.

1958 Douglas DC-8 jetliner will have new Sperry automatic flight control system to relieve pilot fatigue and increase passenger comfort.

19?? Sperry gyroscopic devices are destined to guide space-piercing missiles and vehicles of the future.

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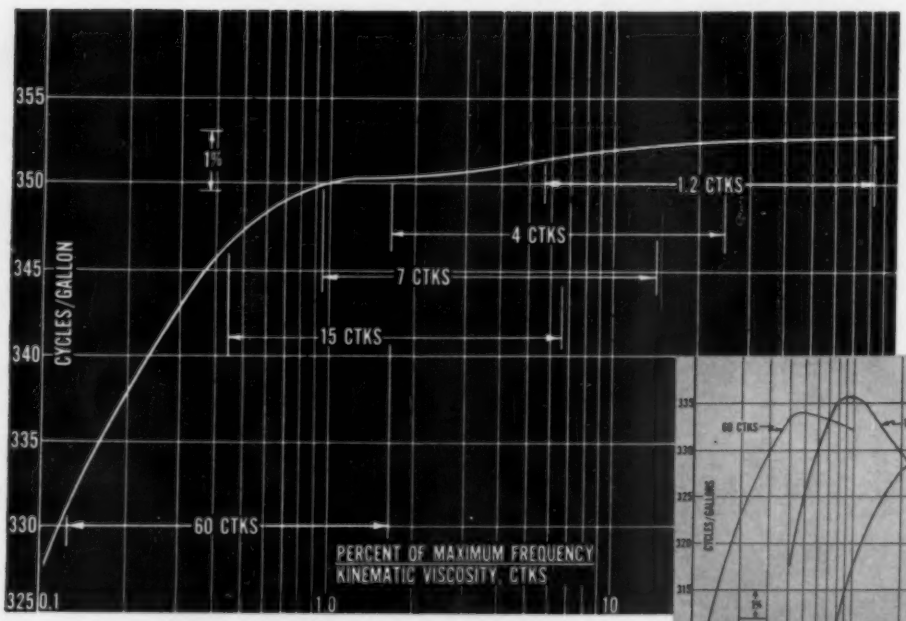
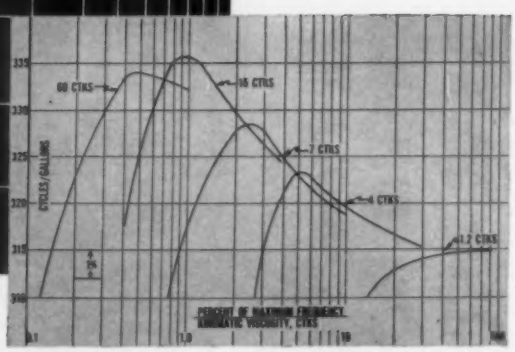
TURBINE FLOWMETER

BREAKS THROUGH

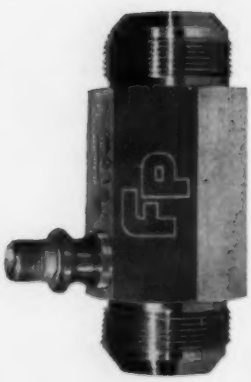
CALIBRATION BARRIER



Performance curve for F&P turbine flowmeters



Performance curves for conventional turbine flowmeters



Re-calibrating for every change in fuel can get to be a very real barrier to metering efficiency. Conventional turbine flowmeters require a separate calibration curve for each change in viscosity. But F & P turbine flowmeters use the same calibration curve for all viscosities: *one meter . . . one calibration . . . handles all fluids.* Dismantling and reassembly for inspection do not affect the calibration in any way.

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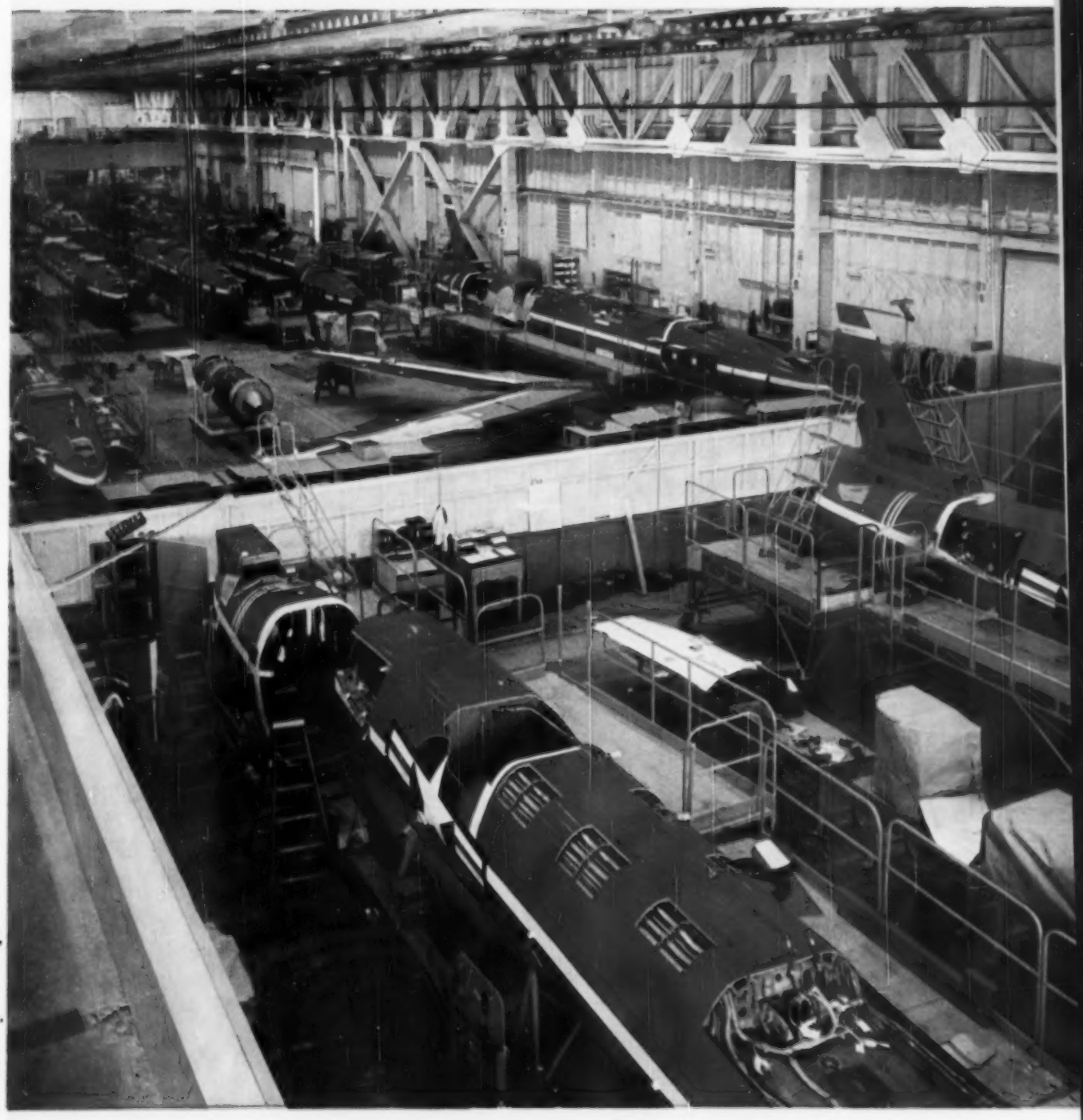
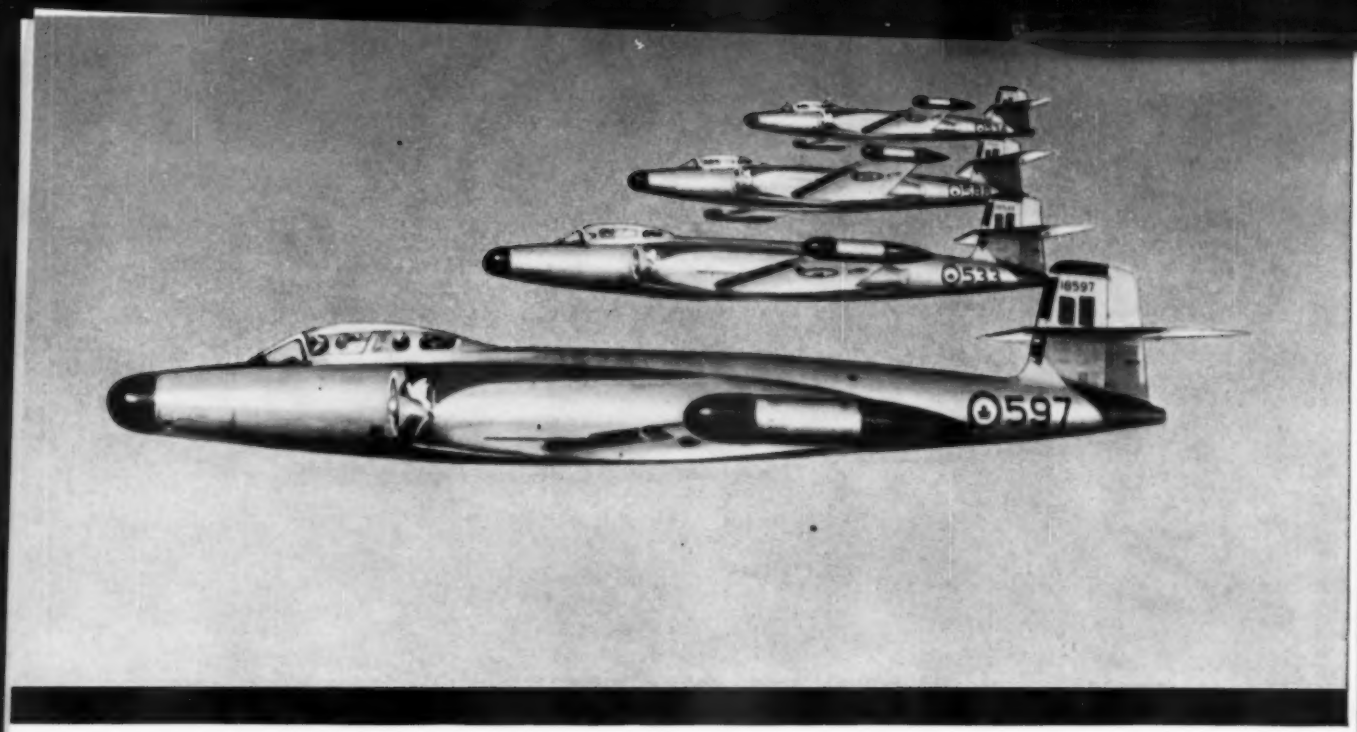


Northrop Snark SM-62 Missile Production Line



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The Avro Arrow, recently unveiled, begins an intensive pre-flight testing program. Under development for the interception role of the RCAF in the new North American Defence Command, the Arrow will have supersonic mission capabilities.

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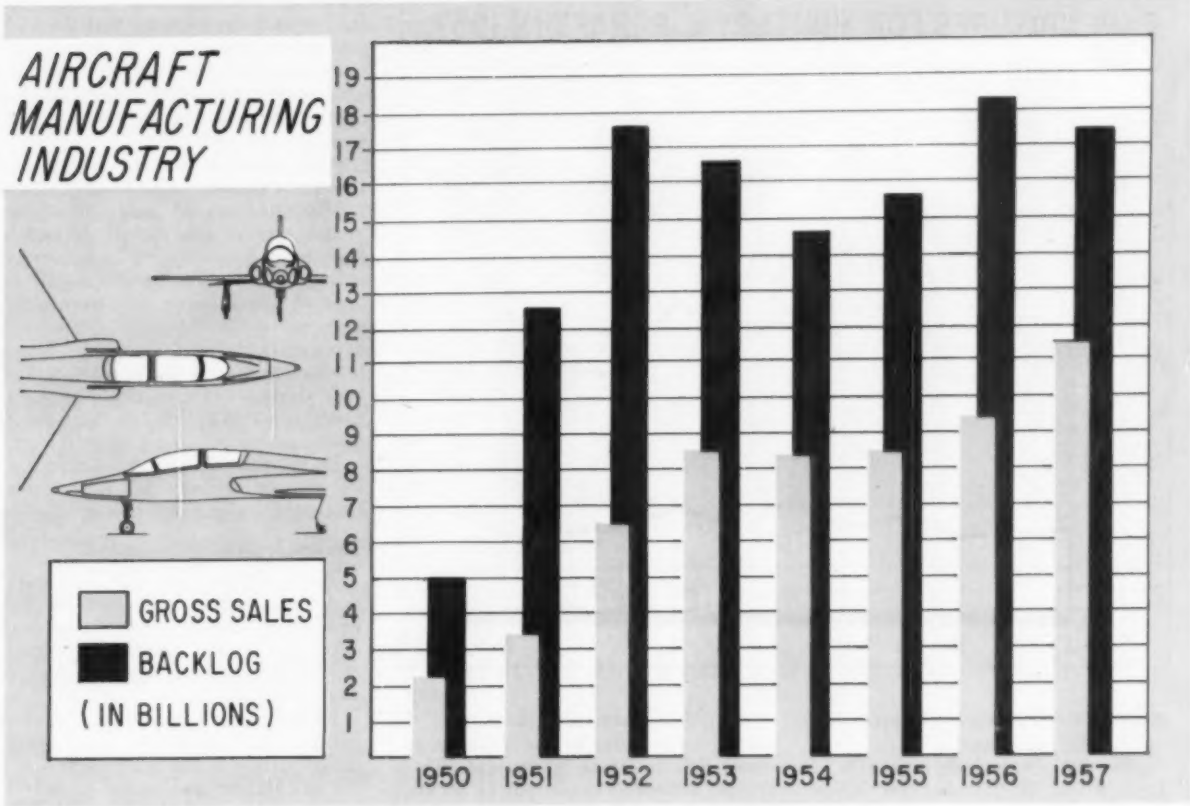


Peak Earnings Cut by Restrictions

The aviation industry hit a post-war sales peak of $11.5 billion in 1957, but accelerated effects of the continuing technological revolution and restrictive and disruptive government policies reduced net earnings and posed grave problems for 1958.

Total sales jumped about $2 billion over the previous 1956 peak of $9.5 billion, with the commercial portion of the 1957 total rising to $2 billion—about 18% of total sales. This compares with about 11% commercial business and 89% military revenues only two years ago.

Despite the record 1957 sales, profits continued to decline on a percentage basis, returning only 2.4% gross sales in 1957 compared with 2.9% for 1956.

The industry entered 1958 with a backlog of $17.5 billion on its order books with nearly $3 billion of this accounted for by commercial business.

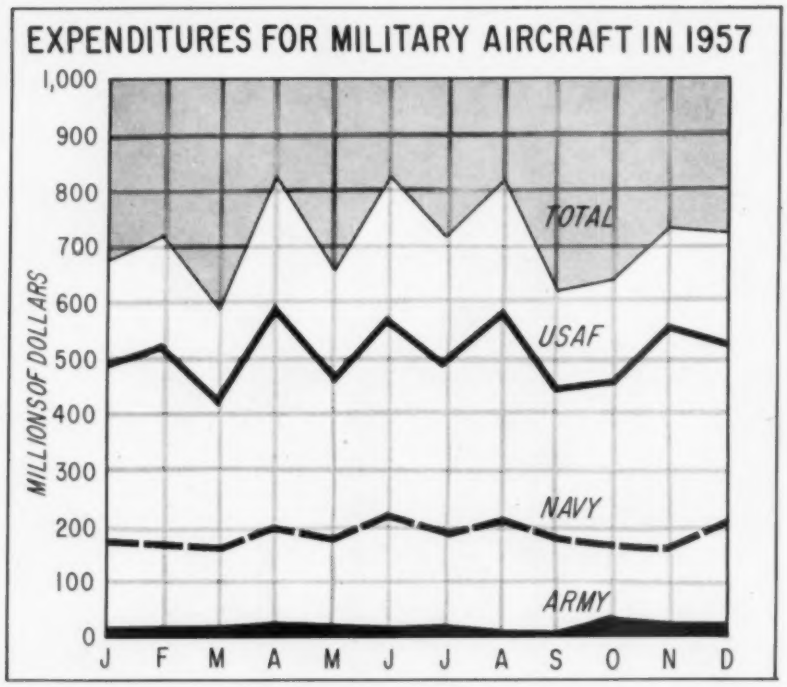
Employment reached a post-war peak of 914,000 by mid-1957 but receded rapidly during the fall and is expected to level off at about 800,000 workers by the first quarter of 1958. Surplus of engineering personnel developed during last fall for the first time in 10 years, but the increased emphasis on research and development in the field of space technology and advanced type missiles started the engineer and scientist hiring rate on the upturn early in 1958.

In addition to the $17.5 billion backlog, the aviation industry faced brighter prospects for 1958 due to an increased defense budget with virtually all of the increased funds being devoted to research and development and procurement of advanced type aircraft, missiles and avionic equipment. The Fiscal 1959 defense budget as originally submitted to Congress by President Eisenhower in mid-January called for $10.4 billion in new contracting authority in these fields plus $2.2 billion for research and development. In addition, a $1.2 billion supplemental defense appropriation request for Fiscal 1958 was rushed to Capitol Hill with indications from Defense Secretary Neil H. McElroy that further supplementals would be submitted to push development and procurement of key aircraft, missile and avionic hardware.

The aviation industry entered 1957 at a high level of activity with prospects for the continued stability that had characterized the industry during the post-Korean years. An orderly and well-planned transition program had been established to integrate the new family of missile weapons into the airpower program. A decline in aircraft production during the next three years was planned as rising production of missiles for operational use was anticipated.

Under-Financing Peril

Some elements in Congress and the technical press had been warning both the industry and the Pentagon for more than 18 months that this element of stability was an illusion because of the continuous under-financing of the Defense Department budget. These critics warned that a day of financial reckoning would arrive soon because the Defense Department funds requested by the President and appropriated by Congress in prior years were



insufficient to finance airpower promised by the executive branch.

This day of reckoning arrived in July 1957 when, at the start of the new fiscal year, it became evident that defense spending to maintain the promised programs would run at a higher rate than calculated by Pentagon fiscal planners and possibly exceed the statutory national debt limit.

Restrictions

This realization triggered a series of abrupt and drastic actions by the Pentagon planners that came close to wrecking the aviation industry financially; delayed the modernization of the airpower forces in being by at least two years; prevented initiations of any vital new research and development programs, started an economic recession.

These actions included:

- **Production cutback and stretchout** of about 25% across the board, including such vital programs as the B-52 bomber the KC-135 jet tanker, the F-101 long range interceptor and many others.
- **Cutback in research** and development funds already authorized.
- **Elimination of all overtime work** and demand for a 12% across-the-board cut in industry overhead.
- **Moratorium on payments** for either work in progress or completed work until March, 1958.
- **Action by the Renegotiation Board** to demand return of profits on prior years operations largely earned by superior performance under incentive type contracts already approved by another branch of the government.

It is hard even now to describe the chaos created during the summer and early fall by these hasty and ill-conceived actions or to compile an accurate total of the damage to our national defense effort and general economic strength.

These policies were formulated at the same time the Soviet Union was successfully flight testing its intercontinental ballistic missile over a 4,000 mi. range and were having their most serious impact at the time the Russians successfully launched the first Earth satellite in October. By the time Sputnik II went into orbit in November, the unreality of this U. S. defense economy program became apparent at even the highest levels of the government and steps were slowly taken to reverse the trend.

The new defense secretary, Neil H. McElroy, who in October succeeded Charles E. Wilson, a proponent of the cut-backs and under-financing policies, took almost immediate action to restore the research and development cuts, assured the industry that the U. S. government would pay its legally contracted debts on time and explored possibilities of accelerating development and production programs for key weapon systems.

Production of military aircraft continued to decline in 1957 to just over 5,000 units from 6,800 in 1956. Commercial aircraft sales, which topped $2 billion for the first time in history, resulted from production of 6,850 aircraft of which about 305 were airline transports with the remainder business flying aircraft and helicopters. Missile production was on the rise during 1957 and, during 1958, is expected to account for about 33% of the total industry sales.

By the end of 1958 the missile backlog will rise to about half of the industry's total in unfilled orders.

Technological Revolution

The problems posed by the continuing technological revolution in flight will add a heavy strain to the research, development and production capacity of the industry during 1958 and the years following.

During the immediate post-war period this revolution was concentrated mainly in the propulsion field as the gas turbine and rocket were added to the reciprocating engine, but the main line of development was still concentrated on manned flight vehicles. During the past five years, the development of unmanned flight vehicles covering the whole spectrum from air-to-air missiles to intercontinental ballistic missiles has been added to the development load.

Now an even broader and more important area of the technical spectacle has brightened with an urgent requirement for the exploration of outer space. The rapid development of its capacity in space technology will impose a research and development expansion on the industry that will perhaps be larger and more complex than the entire field of aircraft and missiles have required to date.

Since the end of World War II, the aviation industry has invested more

Defense Department Expenditures

(In Millions)

Fiscal Year	Aircraft	Missiles	Fiscal Year	Aircraft	Missiles
1951	$2,412	$21	1956	$7,146	$1,168
1952	4,888	169	1957	7,978	2,095
1953	7,417	295	1958*	7,519	2,917
1954	8,335	504	1959*	6,904	3,314
1955	8,037	718			

* Estimates

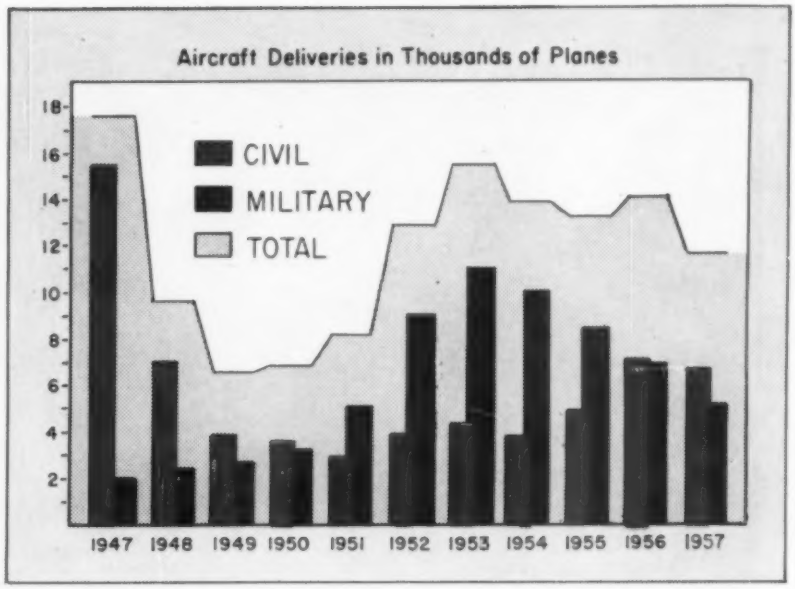
than $1 billion of its own earnings in research and development facilities and already plans to invest at least another billion during the next five years. However, this planned $1 billion investment in private research and development facilities appears extremely conservative in view of the requirements developing. The big limitation of how fast industry can shoulder this burden and progress lies in the financial policies of the government which are making it increasingly difficult for industry to earn a return on its sales sufficient to provide enough funds to finance these research and development facilities at the rate required by our technical race with the Soviet Union. In its post-war research investment the industry has contributed more than $100 million in the ballistic missile field alone.

Next to the enormous research and development problems of the future, the industry is facing an acute problem in its current weapons production programs. Most of these programs have been cut back or stretched out to the point where they represent a minimum rather than near maximum effort possible with existing facilities and personnel. There is no indication in the increased defense budget that these cutbacks will be restored or the stretchouts eased. This means the industry will be producing weapons at an increasing rate of obsolescence and, as the technical race with Russia grows more acute, the industry will find itself in an increasingly vulnerable position against public and congressional criticism of the quality of its products.

New Policies Required

There is a growing feeling in the industry and some thoughtful quarters of the government that it is unreasonable to expect development and production of hypersonic weapons from a government regulatory system that was organized primarily to handle the procurement of battleships and cannon. Among the critical areas in which modern government regulatory policies are required more in keeping with the tasks demanded of the industry are:

- **Limitations of the allowance** of research and development costs.
- **Restriction on earnings** to the point where adequate research and development facilities cannot be privately financed.
- **Military usurping** proprietary rights of contractors.
- **Reduction of progress** payments to contractors even though work involved has been completed.
- **Conflict between** current administration of the Renegotiation Act and the procurement policies of the Defense Department.



Production and Related-Worker Employment

(in thousands)

U. S. AIRCRAFT INDUSTRY

	Aircraft	Acft. Engines and Parts	Props and Parts	Other Acft. Parts and Equipment	Total
1957*	350.7	108.2	14.0	101.5	574.6
1956	329.8	104.4	11.3	95.3	540.8
1955	330.0	94.5	9.3	80.1	513.9
1954	343.2	105.9	11.5	89.8	550.5
1953	347.8	126.5	13.2	89.3	576.8
1952	311.6	98.8	10.4	62.7	483.5
1951	232.3	63.7	7.6	38.3	341.9
1950	138.9	40.0	5.5	22.1	206.4

Total Employment

1957*	537.5	174.3	20.5	145.8	878.1
1956	499.1	165.6	16.9	132.8	814.4
1955	482.2	145.6	13.7	109.4	750.9
1954	497.8	166.8	16.1	125.2	805.6
1953	479.1	177.3	18.0	115.9	790.3
1952	425.9	138.8	14.5	81.6	660.7
1951	313.3	90.8	10.8	48.8	463.6
1950	188.4	55.8	8.3	29.3	281.8

Average Hourly Earnings of Production Workers

1957*	$2.35	$2.39	$2.35	$2.37	$2.36
1956	2.27	2.28	2.27	2.29	2.28
1955	2.17	2.17	2.18	2.17	2.17
1954	2.08	2.09	2.09	2.07	2.08
1953	1.99	2.03	2.03	1.99	2.00
1952	1.87	1.98	2.05	1.88	1.90
1951	1.75	1.89	1.93	1.80	1.79
1950	1.622	1.696	1.743	1.698	1.644

* Preliminary Figures.
SOURCE: Bureau of Labor Statistics.

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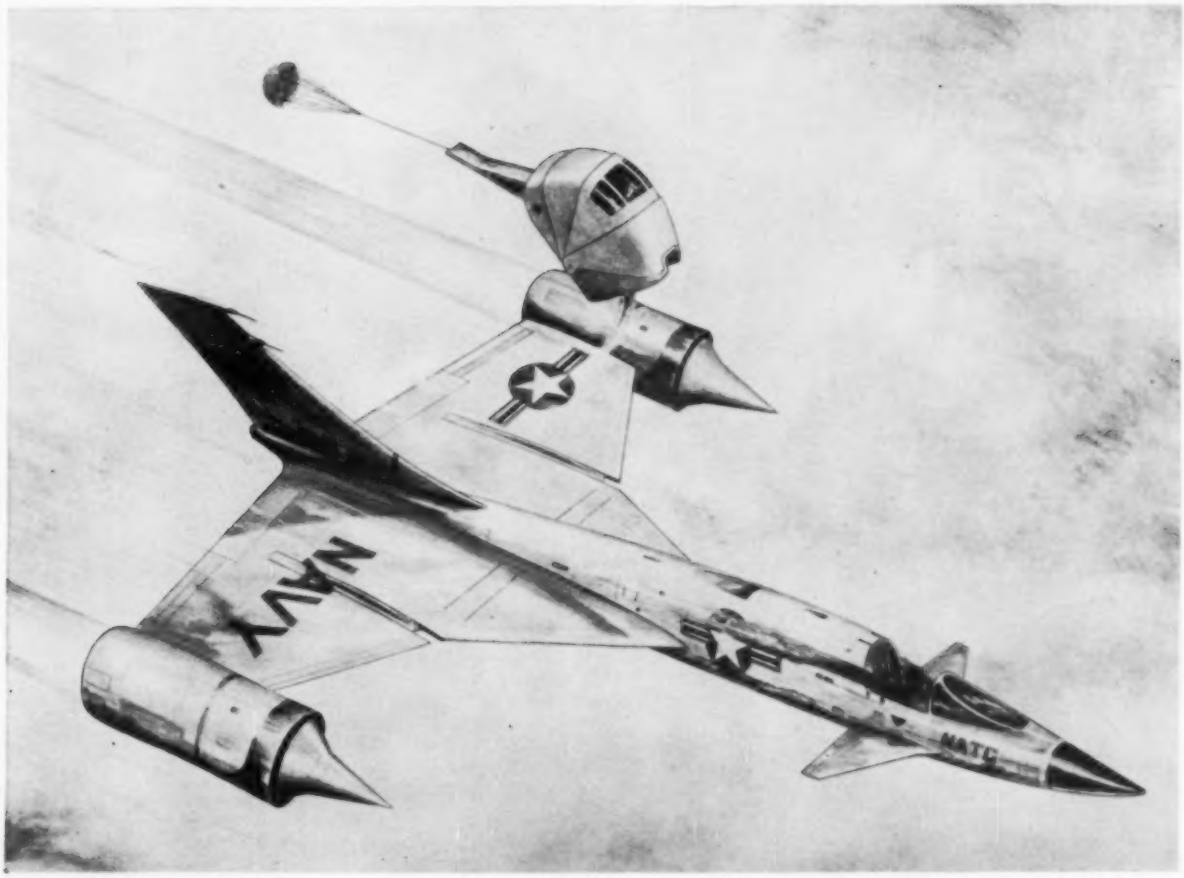

ARTIST'S CONCEPTION of Goodyear escape capsule being ejected from futuristic aircraft of about Mach 4 speed range. Small chute stabilizes capsule. Note canard surfaces adjacent to cockpit.

Military Boosting Escape Programs

By George L. Christian

Dayton, O.—Development of aircraft crew stations, the heart of the entire vehicle, has threatened to lag—and sometimes has conspicuously lagged—behind the rapid strides being made to increase new planes' performance capabilities.

To combat this dangerous deficiency, Air Force's Wright Air Development Center here is attacking with increased vigor the manifold problems of making crew stations and escape systems compatible with new high performance aircraft and manned space vehicles. Dual purpose is to make crewmen comfortable, therefore capable of maximum efficiency during flight and to provide them with maximum chance of survival if escape becomes necessary.

Latest USAF programs to develop adequate escape systems and corrollary equipment range from improving escape systems for todays' Century Series fighters to proposing encapsulated escape methods for such advanced aircraft as the F-108 and WS-110A to studying safe and practical escape systems for manned vehicles travelling at orbital speeds and altitudes.

Anomaly to this pattern is the very high performance X-15 research plane.

In spite of its potential speed of Mach 5-7 and altitude capability of 200-300 miles (AW Feb. 3, p. 26), the plane is equipped with a standard type of upward ejection seat.

Among USAF agencies engaged in escape system research are WADC's Special Projects Branch, Aircraft Laboratory; Crew Station Branch, Operational Development Division and Aero Medical Laboratory.

Special Projects escape system development plan can be compared to a three-stage missile.

• **First stage** of the plan is to give current fighter ejection systems the capability of boosting a crew member out of the aircraft while it is still on the ground. The off-the-runway ejection system, which will eject a pilot safely if an emergency develops during takeoff or landing, is now going into all jet aircraft equipped with upward ejection systems.

• **Second stage** is to encapsulate crew members of high speed, high altitude aircraft to afford them the necessary protection against low atmospheric pressure, wind blast and cold in case they have to abandon their aircraft. A three-pronged research and development program is currently under way in this area. Goal is to eliminate the necessity of crew member wearing the increasing number of cumbersome protective garments, awkward helmets and other gear which so radically restrict his ability to function that many fliers refuse to wear such items as pressure suits. An

Pneumatic pressure regulator which reduces pressure from 3300 psi to 1000 psi. Used for missile launching on Convair's F102.
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Air Force pilot told AVIATION WEEK that, if he wore all the personal equipment prescribed for high altitude missions, he could not fly his plane with the degree of control required to perform safely such routine but precise functions as refueling in flight, making an instrument approach or similar exact maneuvers.

• **Third stage** is to develop an escape system sophisticated enough to allow a man to escape safely from a vehicle traveling at orbital speeds and altitudes. Current thinking is within the performance envelope of the X-15.

Special Projects is currently in the market for a missile to test its second and third stage escape concepts and hopes that Air Research and Development Command will provide one before too long.

Faster But Safer

WADC is proud of the fact that, as Air Force fighters have become faster, they have also become considerably safer to abandon. Center technicians cited these statistics to back up their point.

Ejection fatalities figures for 1955-1956 period of pre-Century Series fighters—F-80s, F-84s and F-86s and similar craft—ran a full 20%. Century Series ejection fatalities have been cut to one-third that figure—7.8%, according to WADC officials. Principal reason for the drop in fatalities, they say, is the increased ejection system automaticity.

When utilization of the off-the-runway system becomes widespread, they hope to cut ejection fatalities to a maximum of 1-2%, an almost irreducible low.

Center authorities base their optimism on these statistics of Century Series ejections and percentage of fatalities:

Aircraft	Number Ejections	Number Fatal	Percent Fatal
F-100	78	*5	6.4%
F-101	4	1	25.0%
F-102	6	**1	16.7%
F-104	5	***0	0.0%
F-105	0	0	0.0%
F-106	0	0	0.0%
Totals	93	7	7.8%

Of the seven fatalities, WADC technicians say they are confident five would have been saved by off-the-runway ejections systems. This would leave a total of only two deaths out of 93 ejections—or almost the 2% figure WADC is striving for.

The two fatalities that could not have been avoided were:

• F-100 (*), one of the five ejection fatalities resulted from equipment mal-

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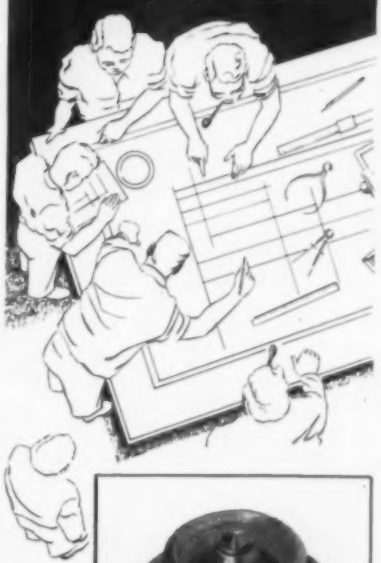

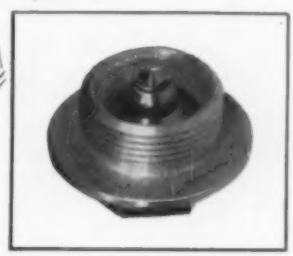

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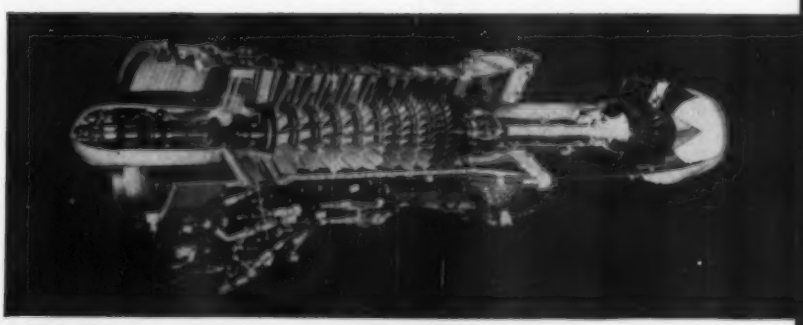

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function. Metal key linking the parachute rip cord to the seat strap broke. As a result, when pilot and seat separated after ejection, the rip cord was not pulled. Pilot, noticing the trouble, pulled the arming knob to deploy the 'chute, but the built-in 2-second delay did not allow sufficient time for the parachute to open and save the pilot.

• **F-102** (**), the single ejection made from this type of plane occurred when the aircraft was in a steep, high speed dive towards the ground. Pilot ejected, but too late.

Score of the five non-fatal F-104 (***) bail-outs is excellent. WADC technicians would not speculate whether there was any relation to the plane's perfect ejection safety record and the fact that, of all the Century Series fighters, it is the only one equipped with a downward, instead of upward, ejection system.

First and only successful supersonic bailout in the U. S. was made by North American's test pilot George Smith while flying an F-100 (AW Nov. 14, 1955, p. 14).

Capsules a Must

Maj. Andrew G. Mayse, who heads up the Crew Station Branch, Operational Development division, at WADC emphatically told AVIATION WEEK that "the capsule concept is a must. . . . It is ridiculous to load up a pilot with emergency personal equipment which appreciably reduces his performance capabilities the entire time he is in the cockpit, especially when the emergencies against which he is being protected occur so seldom. After all, a Navy submariner does not don a diving suit each time his craft submerges. Survivable environment should be built into the vehicle, not loaded on a man's body."

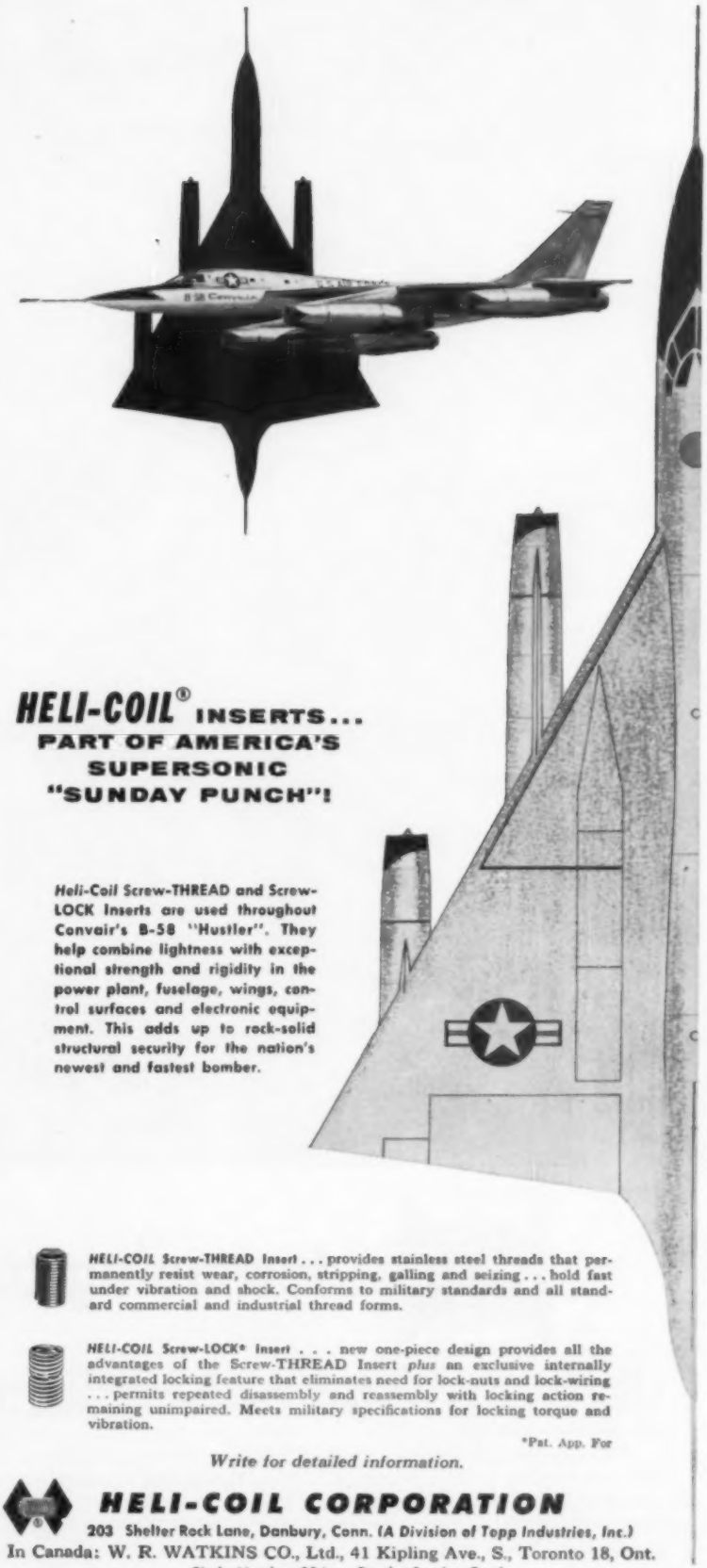
New aircraft, such as the YF-108 long range interceptor and WS-110A chemically-fueled supersonic long range bomber – both being built by North American–will incorporate capsule escape systems. Capsules may also be fitted into upcoming production models of Convair's supersonic B-58 Hustler and an improved version of the company's F-106, if it is built.

Many problems face the designers of escape capsules which must separate cleanly from aircraft flying at supersonic speeds and at great altitudes. Air Force spokesmen listed these as the three most important:

• **Provide physical** clearance between capsule and plane.

• **Avoid subjecting** the capsule to negative lift which might disable the crewman;

• **Eliminate violent** oscillations beyond human endurance by providing adequate stabilizing means. Whether stabilizing



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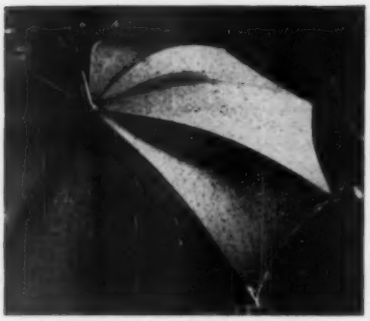

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'chutes, fins or vanes are the answer is still an open question.

It is apparent that at very high altitudes of 80,000-100,000 ft. or more, no such simple devices as drogue 'chutes, fins or vanes can be used for stabilization since the air is too thin to allow such aerodynamic devices to be effective.

Three Capsule Variants

Special Projects technicians listed these three research and development capsule projects:

• **Canopy escape** capsule developed by Stanley Aviation Corp. (AW May 27, 1957, p. 78). System uses the plane's canopy as an integral part of the capsule. When the pilot pulls the emergency handle, he is swiftly and automatically drawn into the capsule which seals itself along the floor line and breaks away from the plane. Company is currently delivering 10 units to Air Research and Development Command's supersonic SMART track at Hurricane Mesa, Utah, for extensive testing.

• **Encapsulated seat** capsule being developed by Goodyear Aircraft Corp. System protects the crewman by slamming three overlapping, sealed segments in front of him very much like a medieval knight dropping the visor of his helmet into place. Segments are hinged to the seat's sides and are normally telescoped one inside the other across the top of the seat.

Company has completed preliminary design of the project and has built a full-scale mock-up. Steps are now being taken to wind tunnel test a 1/20th scale model and conduct dynamic testing on a ¼th scale model of the capsule. Goodyear has also completed preliminary stability tests with a 1/20th scale model on its own small launching track with satisfactory results.

• **Nose capsule** under development by Lockheed Aircraft Corp. System is based on the concept of making the entire nose of a plane a properly conditioned capsule which would break away from the rest of the airframe in an emergency. Lockheed is completing preliminary design work and is scheduling wind tunnel tests.

Bell's X-2 used such an escape system. When Capt. Apt's fatal accident occurred the nose separated satisfactorily from the X-2. However, since the capsule was only equipped with a stabilization and deceleration 'chute but no recovery 'chute, Apt was forced to try to bail out of the capsule after separation, which he failed to do.

WADC officials point to an ironical twist in Apt's accident. They say that the cockpit was sufficiently intact to assume that he might have survived impact with the ground had he not released his belt and harness in his attempt to bail out of the capsule.

Testing capsules in an environment and at speeds which reasonably duplicate the conditions under which they could be expected to be used poses problems.

While the SMART track has a maximum speed capability of about Mach 5, it can only be used to speeds slightly exceeding Mach 2 for capsule testing. Above Mach 2 air pressure imposes more than 7,500 q on the capsule due to the track's low altitude. It would be unrealistic to subject the capsule to greater q forces because, if a pilot needs to escape at speeds exceeding Mach 2, he almost certainly will be at a high altitude where thin air reduces q forces imposed on the capsule's structure.

Since it is also impossible to consider flying at speeds of say Mach 4 to test capsule ejection and behavior Special Projects technicians are developing a program to have a missile launch a capsule containing an anthropomorphic dummy.

Initially technicians are thinking of testing a missile test capsule within the performance envelope of the X-15. They cited this possible pattern which the program might follow. Start might be made with a B-58-type pod fitted with a capsule. First the pod would be launched unboosted, then boosted, then programmed to climb to very high altitudes.

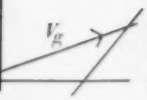
After these test programs have been worked out satisfactorily, the final step of ground launching to very high altitudes and speeds, which finally come in the orbital class, will be undertaken. As the engineers said, "we are now in the market for a missile to test escape capsules."

Rocket-Boosted

Capsules for manned orbital and space vehicles will be highly sophisticated escape systems. They will have to be capable of being rocket-boosted to push them away from the vehicle, will have to rely on nose cone experience to be able to re-enter the atmosphere without undue heating and be capable of sufficient stability to avoid subjecting its occupants to fatal G forces or oscillations.

WADC officials say that when they have assembled all the data pertinent to the capsule—operational envelope, instrumentation, dimensions, etc., they will submit them to Air Research and Development Command which allocates missiles for test purposes. It will also coordinate the work of all agencies wishing to use missiles for test purposes so that as many individual tests as possible are conducted on each missile to save time and money.

RADAN
SYSTEMS



ground speed & drift angle
any time, anywhere, any weather

One look and the pilot KNOWS. In a glance he reads actual ground speed and drift angle, displayed on his flight panel – automatically and continuously.

The system operates entirely without ground aid or celestial fix.

RADAN is the result of GPL's harnessing of Doppler for air navigation—an achievement comparable in magnitude to the breaking of the sound barrier.

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The wraps are off RADAN! The civilian counterpart of GPL's famous military Doppler auto-navigators, is ready and available *now* – for anyone and everyone!

RADAN Systems have behind them millions of miles of experience in transcontinental, oceanic and polar flights . . . save precious time and fuel . . . provide a priceless margin of safety.

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- **RADAN** – small: 4.4 cu. ft.–light: 89 lbs.
- **RADAN** – operates without ground or celestial aids
- **RADAN** – virtually maintenance-free

Now in quantity production, RADAN Systems are manufactured by GPL, who developed and is the nation's leading producer of Doppler air navigation systems. Address inquiries to: General Precision Laboratory Incorporated, Pleasantville, New York.

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GENERAL PRECISION EQUIPMENT CORPORATION GPE

● SPECIFICATIONS

USSR Military and Civil Aircraft

Basic Data				Physical Data			Powerplant	Performance		Armament	Remarks
Mission	Designation	NATO Code name	No. of crew	Overall span ft.	Overall length, ft.	Gross weight, lb.	No., designation and max. power each engine	Maximum speed, mph.	Service ceiling, ft.	No. and type weapons	
FIRST-LINE AIRCRAFT											
STRATEGIC BOMBERS	Type 37	Bison	...	170	140	250,000	4 x Lulko tj. @ 19,500 lb.t.	610	57,000	.....	Equipped for aerial refueling.
	.....	Bear	...	180	150	330,000	4 x tp. @ 12,000 eshp.	550	50,000	.....	Range about 8,000 mi.
	Tu 16	Badger	...	100	105	150,000	2 x Lulko tj. @ 19,500 lb.t.	600	50,000	.....	Comparable to Boeing B-47.
TACTICAL BOMBERS	Il-28	Beagle	3	68	62	.....	2 x RD-45 tj. @ 5,000 lb.t.	600	45,000	2 x 23-mm. 2 x 12.7-mm.	Satellite production and use.
	Il-#	Blowlamp	2	57	70	.....	2 x tj. @ 17,000 lb.t.	750	.....	.....	55-deg. wing sweepback.
	Tu-14	Bosun	3	70	65	50,000	2 x VK-1 tj. @ 5,000 lb.t.	500	.....	.....	Navy torpedo bomber.
	.....	Backfin	3	75	85	.....	2 x tj. @ 17,000 lb.t.	900	.....	.....	Experimental prototype flew summer 1957; 59-deg. wing sweepback.
FIGHTERS	MiG-21	Faceplate	1	33	50	.....	1 x axial tj.	1,200	.....	.....	Operational.
	MiG-#	Fitter	1	.....	...	.....	1 x axial tj.	1,000	.....	.....	Competitor to MiG-21; not in production; used area rule.
	MiG-19	Farmer	1	.....	...	27,000	2 x axial tj. @ 10,000 lb.t.	900	.....	2 x 23-mm.	Low-set slab tail; 3,000 in service.
	Su #	Fishpot	1	25	50	.....	1 x axial tj. @ 22,000 lb. t.	1,200	.....	.....	Delta; 54-in. tailpipe dia.
	Yak-25	Flashlight A	2	40	...	.....	2 x axial tj. @ 8,000 lb.t.	700	.....	2 x 37-mm.	Standard operational all-weather fighter.
	Yak-#	Flashlight B	2	40	55	30,000	2 x axial tj.	800	.....	.....	Light bomber.
	Yak-#	Flashlight C	2	40	55	30,000	2 x axial tj.	800	.....	.....	All-weather; in production.
	MiG-17	Fresco	1	33	37	15,000	1 x VK-2JA tj. @ 6,850 lb.t.	M>1	51,000	2 x 23-mm. 1 x 37-mm.	MiG-15 development.
	MiG-15	Fagot	1	33	36	11,268	1 x VK-2 tj. @ 5,950 lb.t.	683	51,000	2 x 23-mm. 1 x 37-mm.	Satellite production and use; minimum 15,000 built.
HELICOPTERS	Mil-1	Hare	4	48.5[1]	...	4,938	1 x ASh-26B @ 575 hp.	105	.....	.....	Range 400 mi.
	Mil-3	.....	4	47[1]	39	5,180	.....	124	.....	.....	Mi-1T development.
	Mil-4	Hound	2	60[1]	...	12,015	1 x ASh-621R @ 1,000 hp.	130	11,800	None	Used at North Pole stations.
	Mil-6	Hook	...	.....	...	.....	2 x axial tj. @ 4,000 lb.t.	.....	.....	.....	New FAI record: 26,463 lb. to 7,870-ft. altitude.
	Yak-24	Horse	4	60[1]	75	35,000	2 x ASh-82B @ 1,430 hp.	.....	.....	None	Holds two FAI records.
	Ka-18	Hog	...	.....	...	.....	.....	.....	.....	.....	Coaxial rotor, 4 passenger.
	Ka-10	Hat	...	.....	...	.....	.....	.....	.....	.....	Coaxial rotor.
	Ka-15	Hen	...	.....	...	.....	1 x 225 hp.	93	10,000	.....	Coaxial rotor, 2 passenger.
TRANSPORTS	An-2	Colt	2	54	35	11,000	1 x ASh-621A @ 1,000 hp.	137	27,890	None	Holds FAI altitude record.
	An-4	Camp	...	.....	...	77,160	2 x NK tp. @ 4,000 eshp.	.....	.....	Tail turret	Assault transport; Aeroflot freighter.
	An-10	Cat	3-5	.....	...	.....	4 x NK&lv tp. @ 4,000-eshp.	450	30,000	None	85 passengers; grass field operation.
	An-14	(Little Bee)	...	.....	...	.....	2 x piston	143	.....	.....	Antonov design; 6 passengers.
	Il-12	Coach	2-5	104	70	38,000	2 x ASh-82FNV @ 1,850 hp.	252	.....	None	USSR, Polish, Czech airlines; 3,000 built.
	Il-14	Crate	2-5	104	70	36,400	2 x ASh-82T @ 1,900 hp.	200	1,990	None	Il-12 development/replacement; prod. 30/month.
	Il-14M	Crate	...	.....	...	.....	.....	.....	.....	.....	24- passenger version.
	Il-18	Coot	3-5	.....	...	.....	4 x NK&lv tp.@ 4,000 eshp.	.....	30,000	None	70-100 passengers; 2,600-mi. range.
	Tu-70	Cart	4	141	119	.....	4 x ASh-82FNV @ 1,850 hp.	215	.....	None	Tu-4 development (Boeing B-29 copy).
	Tu-104	Camel	3	114	121	120,152	2 x M-209 tj. @ 14,880 lb.t.	560	39,000	None	ICAO range: 1,988 mi.
	Tu-104A	Camel A	3	.....	...	.....	.....	600	.....	.....	Improved engines; 70 passengers.
	Tu-110	Cooker	3	.....	...	.....	4 x Lulko tj. @ 15,000 lb.t.	600	36,000	None	2,000-mi. nonstop full-load range; 50 passengers: 1st class, 100 tourist.
	Tu-114	Cleat	4	.....	...	.....	4 x NK-12M tp. @ 12,000 eshp.	550	35,000	None	Moscow-N.Y. nonstop capability with 100 passengers.
	Li-2	Cab	2	95	64	.....	2 x M-62R @ 1,000 hp.	.....	.....	.....	USSR-built Douglas DC-3.
	Be-6	Madge	...	108	...	51,600	2 x ASh-73 @ 2,000 hp.	260	3,045	.....	Patrol flying boat similar to Martin P5M-1.
SUPPORT AIRCRAFT											
BOMBERS	Il-10	Beast	2	45.5	40	.....	1 x AM-42 @ 2,000 hp.	300	.....	1 x 12.7-mm. 2 x 7.62-mm.	Satellite use.
	Il-26	Butcher	3	68	62	.....	2 x axial tj. @ 5,000 lb.t.	570	45,000	2 x 23-mm. 1 x 20-mm.	Production predecessor of Il-28.
	Tu-4	Bull	6-8	141	99	.....	4 x ASh-82FNV @ 1,850 hp.	225	.....	.....	Russian copy of Boeing B-29.
	Tu-#	Barge	...	185	145	210,000	4 x tp. @ 4,500 eshp.	380	.....	.....	Pre-production quantities; turboprop testbed for Bear.
	Tu-2	Bat	5	61.9	45.3	28,224	2 x ASh-82FNV @ 1,850 hp.	360	36,000	2 x 20-mm. 2 x 12.7-mm.	Polish and Red Chinese service.
FIGHTERS	La-7	Fin	1	32.3	28.5	7,482	1 x ASh-82FNV @ 1,850 hp.	373	.....	.....	Second-line Red Chinese fighter.
	La-9	Fritz	1	31.4	29.4	8,230	1 x ASh-82FNV @ 1,850 hp.	394	.....	1 x 20-mm. 2 x 12.7-mm.	Russian trainer; Chinese fighter.
	La-11	Fang	1	32.5	28.4	7,700	1 x ASh-82FNV @ 1,850 hp.	420	.....	3 x 20-mm.	Last USSR piston-eng. fighter.
	La-#	Fantail	1	37	40	.....	1 x RD-45F @ 5,500 lb.t.	640	.....	2 x 23-mm.	Type 21; was called La-17.
	MiG-9	Fargo	1	34	33	14,000	2 x M-004 @ 2,200 lb.t.	595	.....	2 x 20-mm. 1 x 23-mm.	First USSR twin-jet; now trainer.
	Yak-17	Feather	1	30	28	.....	1 x M-004 @ 2,200 lb.t.	505	.....	2 x 20-mm.	Yak-15 development.
	Yak-23	Flora	1	30	29	.....	1 x RD-500 @ 3,500 lb.t.	610	45,000	.....	Polish, Bulgarian service.
	Yak-3	.....	1	31	29	4,848	1 x VK-105PF @ 1,210 hp.	343	.....	1 x 20-mm. 2 x 12.7-mm.	.....

Abbreviations:

AM—A. A. Mikulin
An—O. K. Antonov
ASh—A. D. Shvetsov
Il—Sergei Ilyyushin
Iv—A. G. Ivchenko
Ka—Nicolai Kamov
La—Semyon Lavochkin

[1] Rotor diameter

M—Motor (old designation)
MiG—Artem Mikoyan & Mikhail Gurevich
Mil—Mikhail Mil
NK—N. D. Kusnetzov
Su—Pavel Sukhoi
tj—turbojet engine
tp—turboprop engine
Tu—Andrei Tupolev
VK—V. Klimov
Yak—Aleksandr Yakovlev

Other NATO code names given to Russian types include: Fred, Box and Bank (Bell P-63A, Douglas A-20 and North American B-25 respectively, sent to USSR under Lend-Lease during WW II); Bob (Il-4), Bark (Il-2), Clam (Il-18 four-engine transport), Crib (Yak-6), Crow (Yak-14), Mark (Yak-7), Mote (MBR-2) and the undisclosed Mole, Mare and Mist.

U. S. Missiles

	GENERAL				STATUS				AIRFRAME				
Category	Missile name	Military designation	Cognizant service	Prime contractor	Research	Development	Production	Service Use	Manufacturer	Overall length, less booster, ft.	Overall span, wings or fins, ft.	Body diameter, ft.	Launching wt., less booster, lb.
Air-to-Air	Diamondback	.....	BuOrd	Philco	..	√	..	..	.....	....	....	....	.....
	Falcon	GAR-1D	USAF	Hughes	..	..	√	√	Hughes	6	2	0.5	10
	Genie	MB-1	USAF	Douglas	..	..	√	√	Douglas	8*	....	....	.....
	Sidewinder	AAM-N-7	BuOrd	Philco/GE	..	..	√	√	GE/Philco	9	....	0.4	15
	Sparrow 1	AAM-N-2	BuAer	Sperry	..	..	..	√	Douglas	12	....	....	30
	Sparrow 3	AAM-N-6	BuAer	Raytheon	..	..	√	..	Raytheon	12	....	....	35
	Zuni	.....	Navy	.....	..	..	√	..	.....	9	....	0.4	10
Air-to-Surface	Bullpup	XASM-N-7	Navy	Martin	..	..	√	..	Martin	11	..	1	54
	Corvus	.....	.....	Temco	√	√	..	..	.....	....	....	....	.....
	Hound Dog	GAM-77	USAF	NAA	..	√	..	..	.....	40	....	....	.....
	Green Quail	GAM-72	USAF	McDonnell	√	√	..	..	.....	....	....	....	.....
	Crossbow	.....	.....	Northrop	..	√	..	..	.....	....	....	....	.....
	Rascal	GAM-63	USAF	Bell	..	..	√	..	Bell	32	.. ..	4	.....
	Wagtail	.....	USAF	M-H	..	..	..	..	.....	....	....	....	.....
Anti-Submarine	Astor	.....	.....	.....	..	..	..	..	.....	....	....	....	.....
	Asroc	.....	.....	M-H	..	..	..	..	.....	....	....	....	.....
	Subroc	.....	.....	.....	..	..	..	..	.....	....	....	....	.....
	Petrel	Mk. 3 Mod O	BuOrd	F'child GMD	..	..	..	√	F'child GMD	24	13	2	3,80
	Rat	.....	Navy	NOTS	..	..	√	..	.....	16	....	....	45
Surface-to-Air	Bull Goose	SM-73	USAF	F'child AD	..	√	√	..	F'child AD	....	....	....	.....
	Bomarc	IM-99	USAF	Boeing	..	..	√	..	Boeing	47	18	3	15,00
	Hawk 1	.....	ArmyOrd	Raytheon	..	√	√	..	No./Ray.	17	....	1.2	.....
	Nike-Ajax	XSAM-A-7	ArmyOrd	WeEl	..	..	√	√	Douglas	21	....	1	.....
	Nike-Hercules	XSAM-A-25	ArmyOrd	WeEl	..	..	√	..	Douglas	27	....	2.5	.....
	Nike-Zeus	.....	ArmyOrd	WeEl	√	√	..	..	Douglas	....	....	....	.....
	Talos	SAM-N-6	BuOrd	Bendix	..	..	√	..	McDonnell	20	....	2.5	3,00
	Tartar	.....	BuOrd	APL/Convair	..	√	√	..	Convair	....	....	....	.....
	Terrier 1	SAM-N-7	BuOrd	Convair	..	..	√	√	Convair	13	....	....	1,00
	Terrier 2	.....	BuOrd	Convair	..	..	√	√	Convair	....	....	....	.....
Surface-to-Surface	Atlas	SM-65	USAF	Convair	..	√	√	..	Convair	75	....	10	243,00
	Corporal	XM4E1	ArmyOrd	Gilfillan/Firestone	..	..	√	√	Firestone	46	....	2.5	12,00
	Dart	XSSM-A-23	ArmyOrd	ADC	..	..	√	..	Utica-Bend	5	3	0.7	.....
	Honest John	M-31	ArmyOrd	Douglas	..	..	√	√	Douglas	27	8	2.5	6,00
	Jupiter	.....	ArmyOrd	Chrysler	..	..	√	..	Chrysler	58	....	8.8	105,00
	Lacrosse	SSM-A-12	ArmyOrd	Martin	..	..	√	..	Martin	20	....	....	.....
	Little John	XM-47	ArmyOrd	Emerson	..	√	√	..	Douglas	12	....	1.0	.....
	Mace	TM-76	USAF	Martin	..	..	√	..	Martin	44	23	4.5	.....
	Matador	TM-61C	USAF	Martin	..	..	..	√	Martin	40	29	4.5	12,00
	Pershing	.....	ArmyOrd	ABMA	√	√	..	..	.....	....	....	....	.....
	Polaris	.....	Navy	Lockheed	√	√	..	..	Lockheed	47	....	....	28,00
	Redstone	XSSM-A-14	ArmyOrd	Chrysler	..	√	..	..	Reynolds	69	....	5	.....
	Regulus 1	SSM-N-8a	BuAer	Ch. Vought	..	..	√	√	Ch. Vought	33	21	....	12,00
	Regulus 2	SSM-N-9a	BuAer	Ch. Vought	..	√	√	..	Ch. Vought	57	20	....	22,00
	Sergeant	.....	ArmyOrd	JPL/Sperry	..	√	√	..	.....	30	....	....	.....
	Snark	SM-62	USAF	Northrop	..	√	√	√	Northrop	69	42	....	50,00
	Thor	SM-75	USAF	Douglas	..	√	√	..	Douglas	62	....	8	110,00
	Titan	SM-68	USAF	Martin	√	√	..	..	Martin	90	....	10	222,00

U. S. Missiles

	GENERAL				STATUS				AIRFRAME				
Category	Missile name	Military designation	Cognizant service	Prime contractor	Research	Development	Production	Service Use	Manufacturer	Overall length, less booster, ft.	Overall span, wings or fins, ft.	Body diameter, ft.	Launching wt., less booster, lb.
Air-to-Air	Diamondback	.....	BuOrd	Philco	..	✓	..	..	.....	....	....	....	.....
	Falcon	GAR-1D	USAF	Hughes	..	..	✓	✓	Hughes	6	2	0.5	100
	Genie	MB-1	USAF	Douglas	..	..	✓	✓	Douglas	8*	....	....	.....
	Sidewinder	AAM-N-7	BuOrd	Philco/GE	..	..	✓	✓	GE/Philco	9	....	0.4	155
	Sparrow 1	AAM-N-2	BuAer	Sperry	..	..	..	✓	Douglas	12	....	....	300
	Sparrow 3	AAM-N-6	BuAer	Raytheon	..	..	✓	..	Raytheon	12	....	....	350
	Zuni	.....	Navy	.....	..	..	✓	..	.....	9	....	0.4	107
Air-to-Surface	Bullpup	XASM-N-7	Navy	Martin	..	..	✓	..	Martin	11	..	1	540
	Corvus	.....	.....	Temco	✓	✓	..	..	.....	....	....	....	.....
	Hound Dog	GAM-77	USAF	NAA	..	✓	..	..	.....	40	....	....	.....
	Green Quail	GAM-72	USAF	McDonnell	✓	✓	..	..	.....	....	....	....	.....
	Crossbow	.....	.....	Northrop	..	✓	..	..	.....	....	....	....	.....
	Rascal	GAM-63	USAF	Bell	..	..	✓	..	Bell	32	.. ..	4	.....
	Wagtail	.....	USAF	M-H	..	..	..	..	.....	....	....	....	.....
Anti-Submarine	Astor	.....	.....	.....	..	..	..	..	.....	....	....	....	.....
	Asroc	.....	.....	M-H	..	..	..	..	.....	....	....	....	.....
	Subroc	.....	.....	.....	..	..	..	..	.....	....	....	....	.....
	Petrel	Mk. 3 Mod O	BuOrd	F'child GMD	..	..	..	✓	F'child GMD	24	13	2	3,800
	Rat	.....	Navy	NOTS	..	..	✓	..	.....	16	....	....	450
Surface-to-Air	Bull Goose	SM-73	USAF	F'child AD	..	✓	✓	..	F'child AD	....	....	....	.....
	Bomarc	IM-99	USAF	Boeing	..	..	✓	..	Boeing	47	18	3	15,000
	Hawk I	.....	ArmyOrd	Raytheon	..	✓	✓	..	No./Ray.	17	....	1.2	.....
	Nike-Ajax	XSAM-A-7	ArmyOrd	WeEl	..	..	✓	✓	Douglas	21	....	1	.....
	Nike-Hercules	XSAM-A-25	ArmyOrd	WeEl	..	..	✓	..	Douglas	27	....	2.5	.....
	Nike-Zeus	.....	ArmyOrd	WeEl	✓	✓	..	..	Douglas	....	....	....	.....
	Talos	SAM-N-6	BuOrd	Bendix	..	..	✓	..	McDonnell	20	....	2.5	3,000
	Tartar	.....	BuOrd	APL/Convair	..	✓	✓	..	Convair	....	....	....	.....
	Terrier 1	SAM-N-7	BuOrd	Convair	..	..	✓	✓	Convair	13	....	....	1,000
	Terrier 2	.....	BuOrd	Convair	..	..	✓	✓	Convair	....	....	....	.....
Surface-to-Surface	Atlas	SM-65	USAF	Convair	..	✓	✓	..	Convair	75	....	10	243,000[1]
	Corporal	XM4E1	ArmyOrd	Gilfillan/Firestone	..	..	✓	✓	Firestone	46	....	2.5	12,000
	Dart	XSSM-A-23	ArmyOrd	ADC	..	..	✓	..	Utica-Bend	5	3	0.7	.....
	Honest John	M-31	ArmyOrd	Douglas	..	..	✓	✓	Douglas	27	8	2.5	6,000
	Jupiter	.....	ArmyOrd	Chrysler	..	..	✓	..	Chrysler	58	....	8.8	105,000[1]
	Lacrosse	SSM-A-12	ArmyOrd	Martin	..	..	✓	..	Martin	20	....	....	.....
	Little John	XM-47	ArmyOrd	Emerson	..	✓	✓	..	Douglas	12	....	1.0	.....
	Mace	TM-76	USAF	Martin	..	..	✓	..	Martin	44	23	4.5	.....
	Matador	TM-61C	USAF	Martin	..	..	..	✓	Martin	40	20	4.5	12,000
	Pershing	.....	ArmyOrd	ABMA	✓	✓	..	..	.....	....	....	....	.....
	Polaris	.....	Navy	Lockheed	✓	✓	..	..	Lockheed	47	....	....	28,000
	Redstone	XSSM-A-14	ArmyOrd	Chrysler	..	✓	..	..	Reynolds	60	....	5	.....
	Regulus 1	SSM-N-8a	BuAer	Ch. Vought	..	..	✓	✓	Ch. Vought	33	21	....	12,000
	Regulus 2	SSM-N-9a	BuAer	Ch. Vought	..	✓	✓	..	Ch. Vought	57	20	....	22,000
	Sergeant	.....	ArmyOrd	JPL/Sperry	..	✓	✓	..	.....	30	....	....	.....
	Snark	SM-62	USAF	Northrop	..	✓	✓	✓	Northrop	69	42	....	50,000
	Thor	SM-75	USAF	Douglas	..	✓	✓	..	Douglas	62	....	8	110,000[1]
	Titan	SM-68	USAF	Martin	✓	✓	..	..	Martin	90	....	10	222,000[1]

	POWERPLANT				GUIDANCE		PERFORMANCE		
Launching wt., less booster, lb.	Manufacturer	No. of engines	Engine designation	Rated thrust, lb.	Manufacturer	Type of guidance	Maximum Mach number	Maximum range, mi.	REMARKS
.....	.....	..	.....	.....	.....	Infrared	.....	.....	Offspring of Sidewinder
100	Thiokol	1	M-58 spr.	.....	Hughes	Radar hom'g	.....	.....	GAR-2A uses infrared hom'g
.....	Aerojet	1	spr.	.....	.....	Unguided	.....	1.5	N.C.; guided version in development
155	.....	1	spr.	.....	Philco	Infrared	.....	2	NOTS-developed; with fleet
300	Aerojet	1	spr.	.....	Sperry	Beam rider	2.5	.....	With fleet
350	Aerojet	1	spr.	.....	Raytheon	Radar hom'g	2.5	.....	Sparrow I successor
107	.....	..	.....	.....	.....	Unguided	3	.....	Also air-to-ground weapon
540	Aerojet	1	spr.	.....	.....	Command	.....	.....	Bulldog will have longer range
.....	RMI	..	.....	.....	Texas Instr./W. L. Maxon	.....	.....	.....	
.....	P&W	..	J52 tj.	.....	.....	.....	.....	.....	For B-52
.....	GE	..	.....	.....	.....	.....	.....	.....	Diversionary missile
.....	.....	..	.....	.....	.....	.....	.....	.....	Homes on enemy radar
.....	Bell	3	lpr.	12,000	Bell	Radar-command	1.5	100	On B-47; Shrike was test vehicle
.....	.....	..	.....	.....	M-H	Inertial	.....	.....	
.....	.....	..	.....	.....	.....	.....	.....	.....	
.....	.....	..	.....	.....	.....	.....	.....	.....	
.....	.....	..	.....	.....	.....	.....	.....	.....	
3,800	F'child ED	1	J44 tj.	1,000	F'child GMD	Radar hom'g	0.7	.....	Production discontinued
450	ABL	1	spr.	.....	.....	Acoustical	.....	.....	Rocket-boosted torpedo
.....	F'child ED	1	J83 tj.	.....	F'child GMD	.....	.....	.....	Diversionary missile
15,000	Marquardt	2	rj.	10,000	Westinghouse	GCC/radar hom'g	3.5	200	N.C.; Aerojet lpr. booster
.....	Aerojet	1	spr.	.....	Raytheon	Radar hom'g	.....	22	Low-level; complements Nike
.....	GFE	1	spr.	2,000	WeEl	Command	.....	25	Deployed in U. S.; spr. booster
.....	GFE	1	spr.	.....	WeEl	Command	.....	.....	Formerly Nike B; N.C.; 14.5-ft. booster
.....	Gr. Central	..	spr.	.....	.....	Command	.....	.....	Anti-missile missile
3,000	Bendix	1	rj.	.....	Sperry/FTL	Beam rider/passive hom'g	2.1	25	Land version is for Army
.....	.....	1	spr.	.....	.....	.....	.....	10	Destroyer armament
1,600	M.W. Kellogg	1	spr.	.....	Reeves/FTL	Beam rider	2.5	10	Mobile launcher for USMC
.....	.....	1	spr.	.....	Sperry	Beam rider	2.5	20	Frigate armament
243,000[1]	NAA	1	lpr.	135,000	GE/Burroughs	Radar-Doppler Command	20	5,500	Booster: 2x100,000-lb. t. lpr.; N.C.
12,000	Ryan	1	lpr.	.....	Gilfillan	Command	.....	100	N.C.; deployed in Europe
.....	Gr.Central	1	smokeless spr.	.....	Wagner	Optical	.....	.....	Anti-tank weapon
6,000	Hercules	1	spr.	.....	.....	Unguided	.....	15	N.C.; deployed Europe, Japan
105,000[1]	NAA	1	lpr.	135,000	Ford Inst.	Inertial	12	1,500	Army IRBM
.....	Thiokol	1	spr.	.....	FTL	Command	.....	8	Close tactical support
.....	.....	1	spr.	.....	.....	Unguided	.....	.....	Supplements Honest John
.....	Allison	1	J33-A-37 tj.	3,700	Goodyear/AC	ATRAN/Inertial	0.9	650	Former TM-61B; high- and low-altitude capability
12,000	Allison	1	J33-A-37 tj.	3,700	GFE/Martin	MSQ radar/Shanicle	0.9	.....	N.C.; Replaced TM-61A in Europe, Formosa
.....	.....	1	spr.	.....	.....	.....	.....	.....	Solid version of Redstone
28,000	Aerojet	..	spr.	.....	GE/MIT	Inertial	.....	1,500	Navy IRBM; N.C.
.....	NAA	1	lpr.	75,000	Ford Inst.	Inertial	.....	200	N.C.; warhead separates
12,000	Allison	1	J33-A-18A tj.	4,600	Sperry	Command	0.9	500	N.C.; Aerojet spr. booster
22,000	GE	1	J79-GE-3 tj.	10,000+	AC	Command or inertial	2	1,000	N.C.; Aerojet spr. booster
.....	Thiokol	1	spr.	.....	.....	Inertial	.....	200	N.C.; succeeds Corporal
50,000	P&W	1	J57 tj.	11,000	Northrop	Stell. Inert.	0.9	5,000	Assigned to SAC; N.C.
110,000[1]	NAA	1	lpr.	165,000	AC	Inertial	.....	1,500	USAF IRBM; N.C.
222,000[1]	Aerojet	3	lpr.	.....	Arma/Bell Tele. Lab.	Inertial/radio inertial	20+	5,500	USAF ICBM; N.C.

U. S. Military Aircraft

BASIC AIRCRAFT DATA					DIMENSIONS				WEIGHTS			POWERPLANT
Manufacturer	Military designation	Military name	Primary mission	Number in crew	Overall span	Overall length	Overall height, 3-pt.	Gross wing area, sq. ft.	Weight empty, lb.	Normal gross wt., lb.	Maximum gross wt., lb.	Number, make, model and max. rating
Beech Aircraft Corp.	T-34A	Mentor	Trainer	2	32′ 10″	25′ 11″	9′ 7″	178	2,170	2,900	.....	1 Con. O-470-13 @ 225 hp.
Wichita, Kans.	.....	Jet Mentor	Trainer	2	32′ 9″	30′	9′ 9″	178	3,034	4,360	.....	1 Con. J69-T-9 @ 920 lb.t.
Boeing Airplane Co.	B-47E	Stratojet	Med. Bomber	3	116′	107′	28′	.....	.....	.....	200,000	6 GE J47-GE-25 @ 6,000 lb.t.
Seattle, Wash.	B-52A	Stratofortress	Heavy Bomber	6	185′	152′ 9″	48′ 3″	4,000	.....	350,000+	.....	8 P&W J57-P-1W @ 10,000+
	B-52B	Stratofortress	Heavy Bomber	6	185′	152′ 9″	48′ 3″	4,000	.....	350 000+	.....	8 P&W J57-P-1W @ 10,000+
	B-52C	Stratofortress	Heavy Bomber	6	185′	152′ 9″	48′ 3″	4,000	.....	400,000+	.....	8 P&W J57-P-19W @ 10,000+
	B-52D	Stratofortress	Heavy Bomber	6	185′	152′ 9″	48′ 3″	4,000	.....	400,000+	.....	8 P&W J57-P-19W @ 10,000+
	B-52E	Stratofortress	Heavy Bomber	6	185′	152′ 9″	48′ 3″	4,000	.....	400,000+	.....	8 P&W J57-P-19W @ 10,000+
	B-52F	Stratofortress	Heavy Bomber	6	185′	152′ 9″	48′ 3″	4,000	.....	400,000+	.....	8 P&W J57-P-43W @ 10,000+
	B-52G	Stratofortress	Heavy Bomber	6	185′	157′ 9″	40′ 9″	4,000	.....	400,000+	.....	8 P&W J57-P-43W @ 10,000+
Cessna Aircraft Co.	T-37A	.....	Trainer	2	33′ 10″	29′ 3″	9′ 2″	183.9	3,945	6,547	.....	2 Con. J69-T-9 @ 920 lb.t.
Wichita, Kans.	TL-19D	Bird Dog	Inst. Trainer	2	36′	25′ 9″	7′ 6″	174	1,604	2,400	.....	1 Con. O-470-L @ 213 hp.
	OE-2	.....	Recon.	2	36′	25′	7′ 6″	174	1,853	2,650	.....	1 Con. O-470-2 @ 265 hp.
Convair Division	F-102A	Delta Dagger	AW Interceptor	1	38′ 1″	68′ 3″	21′ 2″	.....	.....	.....	.....	1 P&W J57-P-23 @ 10,000+
General Dynamics Corp.	TF-102A	.....	Trainer	2	38′ 1″	59′ 2″	20′ 7″	.....	.....	.....	.....	1 P&W J57-P-23 @ 10,000+
San Diego, Calif.	F-106A	Delta Dart	AW Interceptor	1	.....	.....	.....	.....	.....	.....	.....	1 P&W J75 @ 15,000+ lb.t.
	T-29C	Flying Classroom	Crew Trainer	4	91′ 9″	74′ 8″	27′ 3″	817	29,000	43,575	43,575	2 P&W R2800-99W @ 2,500
Fort Worth Div.	B-36J	.....	Heavy Bomber	15	230′	162′ 1″	46′ 9″	4,772	.....	.....	400,000+	6 P&W R4360-53 @ 3,800 hp
												4 GE J47-GE-19 @ 5,200 lb
	B-58	Hustler	Bomber	3	55′	97′	31′	.....	.....	160,000	.....	4 GE J79-GE-1 @ 10,000+ lb
	WS-125A	.....	Bomber	..	.....	.....	.....	.....	.....	.....	.....	Nuclear power (P&W)
Douglas Aircraft Co., Inc.	B-66B	Destroyer	Tac. Bomber	3	72′ 6″	75′ 2″	23′ 7″	780	42,086	78,000	83,000	2 All. J71-A-11 @ 10,000 lb.t.
Long Beach, Calif.	RB-66B	Destroyer	Night Recon.	3	72′ 6″	75′ 2″	23′ 7″	780	42,797	70,000	83,000	2 All. J71-A-11 @ 10,000 lb.t.
	WB-66	Destroyer	Weather Recon.	5	72′ 6″	75′ 2″	23′ 7″	780	43,476	70,000	83,000	2 All. J71-A-13 @ 10,200 lb.t.
El Segundo Div.	AD-7	Skyraider	Attack	1–3	50′	39′	15′ 8″	400	12,094	18,000	.....	1 Wr. R3350 @ 2,700 hp.
	A3D-2	Skywarrior	Attack	3	72′ 6″	73′ 6″	22′ 9″	260	.....	70,000	.....	2 P&W J57-P-10 @ 10,000+
	A4D-2	Skyhawk	Attack	1	27′ 6″	39′ 1″	15′ 2″	.....	8,300	15,000	.....	1 Wr. J65-W-4 @ 7,200 lb.t.
	F4D-1	Skyray	Interceptor	1	33′ 6″	44′ 4″	13′	557	.....	25,000	.....	1 P&W J57 @ 10,000+ lb.t.
	F5D-1	Skylancer	Interceptor	1	.....	.....	.....	.....	.....	.....	.....	1 P&W J57-P-12 @ 10,000+
Grumman Aircraft Eng'rg. Corp.	F9F-8T	Cougar	Trainer	2	34′ 6″	48′ 6″	12′ 1″	.....	.....	20,600	.....	1 P&W J48-P-8A @ 7,200 lb.
Bethpage, L.I., N.Y.	F11F-1	Tiger	Fighter	1	31′ 8″	46′ 10″	12′ 9″	.....	.....	.....	.....	1 Wr. J65-W-18 @ 7,200+ lb
	F11F-1F	Super Tiger	Fighter	1	31′ 8″	46′ 10″	12′ 9″	.....	.....	.....	.....	1 GE YJ79-GE-3 @ 10,000+
	S2F-1	Tracker	AsW	4	69′ 8″	42′ 3″	16′ 3″	.....	.....	.....	.....	2 Wr. R1820-82 @ 1,525 hp.
	WF-2	Tracer	AEW	4	69′ 8″	.....	.....	597	.....	.....	.....	2 Wr. R1820-82 @ 1,525 hp.
	OF-1	Mohawk	Observation	2	42′	42′ 9″	15′ 7″	330	7,772	10,423	.....	2 Lyc. T53-L-3 @ 1,005 eshp
	.....	.....	Attack	2	.....	.....	.....	.....	.....	.....	.....	Turbojet
	SA-16B	Albatross	Rescue	6	96′ 6″	62′ 4″	26′ 11″	.....	25,000	.....	35,000	2 Wr. R1820-76A @ 1,425 hp
Lockheed Aircraft Corp.	F-104A	Starfighter	Interceptor	1	21′ 11″	54′ 9″	13′ 6″	.....	.....	.....	.....	1 GE J79-GE-3A @ 10,000+
Burbank, Calif.	F-104B	.....	Trainer	2	21′ 11″	54′ 9″	13′ 6″	.....	.....	.....	.....	1 GE J79 @ 10,000+ lb.t.
	EC-121D	Sup. Constellation	AEW	32	123′ 5″	116′ 2″	27′	1,654	.....	.....	.....	4 Wr. R3350 @ 3,250 hp.
	T-33A	.....	Trainer	2	38′ 11″	37′ 8″	11′ 8″	238	8,400	11,700	15,000	1 All. J33-A-35 @ 5,200 lb.t.
	P2V-7	Neptune	AsW	..	103′	91′ 5″	29′ 4″	1,000	47,500	75,500	.....	2 Wr. R3350-32W @ 3,500 h
												2 We. J34 @ 3,400 lb.t.
	T2V-1	Seastar	Trainer	2	42′	38′	13′	.....	.....	.....	16,400	1 All. J33-A-24 @ 6,100 lb.t.
	W2V-1	.....	AEW	..	.....	.....	.....	.....	.....	.....	.....	4 All. T56+2 West. J34
	U-2	.....	Research	1	.....	.....	.....	.....	.....	.....	.....	1 P&W J57 @ 10,000+ lb.t.
Marietta, Ga., Div.	WS-125A	.....	Bomber	..	.....	.....	.....	.....	.....	.....	.....	Nuclear power (Gt.)
The Martin Co.	B-57E	.....	Tow Target	2	64′	65′ 9″	15′ 7″	960	.....	.....	55,000	2 Wr. J65-W-5 @ 7,220 lb.t.
Baltimore, Md.	P5M-2	Marlin	AsW	11	118′ 2″	98′	32′ 8″	1,406	49,180	74,442	85,000	2 Wr. R3350-32W @ 3,400 h
	YP6M-1	Seamaster	Mine-Layer	4	100′	134′	31′	1,900	.....	.....	160,000	4 All. J71 @ 10,000 lb.t.
McDonnell Aircraft Corp.	F-101A	Voodoo	Fighter-Bomber	1	40′	67′ 5″	18′	.....	.....	.....	.....	2 P&W J57-P-13 @ 10,000+
St. Louis, Mo.	F-101B	Voodoo	Interceptor	2	40′	67′ 5″	18′	.....	.....	.....	.....	2 P&W J57-P-55 @ 10,300+
	RF-101C	Voodoo	Recon.	1	40′	69′ 3″	18′	.....	.....	.....	.....	2 P&W J57-P-13 @ 10,000+
	F4H-1	.....	AW Interceptor	2	.....	.....	.....	.....	.....	.....	60,000	2 GE J79-GE-2 @ 10,000+ l
North American Aviation, Inc.	WS-110A	.....	Bomber	..	.....	.....	.....	.....	.....	.....	.....	GE J93 using chemical fuel
Los Angeles, Calif.	F-86F	Sabre	Fighter-Bomber	1	37′ 1″	37′ 5″	14′ 7″	.....	.....	.....	17,000	1 GE J47-GE-27 @ 5,970 lb.t
	F-86H	Sabre	Fighter-Bomber	1	37′ 1″	38′ 8″	15′	.....	.....	.....	.....	1 GE J73-GE-3 @ 9,000 lb.t.
	F-86K	Sabre	Interceptor	1	37′ 1″	42′ 4″	15′	.....	.....	18,500	20,347	1 GE J47-GE-33 @ 5,600 lb.t
	F-86L	Sabre	Interceptor	1	37′ 1″	42′ 4″	15′	.....	.....	.....	.....	1 GE J47-GE-33 @ 7,650+ l
	F-100C	Super Sabre	Fighter	1	38′	47′	15′	.....	.....	.....	.....	1 P&W J57-P-7 @ 10,000+ l
	F-100D	Super Sabre	Fighter-Bomber	1	38′	47′	16′	.....	.....	.....	.....	1 P&W J57-P-21 @ 10,000+
	F-107A	.....	Research	1	36′ 7″	60′ 10″	19′ 8″	.....	.....	.....	.....	1 P&W J75 @ 15,000+ lb.t.
	YF-108	.....	Interceptor	..	.....	.....	.....	.....	.....	.....	.....	.....
	X-15	.....	Research	1	22′	50′	13′ 6″	.....	.....	.....	33,000	1 RMI rocket @ 60,000 lb.t.
Columbus, Ohio, Div.	T-28C	Trojan	Trainer	2	40′ 7″	34′ 4″	12′ 7″	.....	.....	.....	8,247	1 Wr. R1820 @ 1,425 hp.
	FJ-3	Fury	Fighter	1	37′ 1″	37′ 7″	15′ 8″	.....	.....	.....	18,000	1 Wr. J65 @ 7,200 lb.t.
	FJ-4B	Fury	Fighter-Bomber	1	39′ 1″	36′ 7″	13′ 11″	338	.....	19,900	.....	1 Wr. J65-W-16A @ 7,700 lb.
	XA3J-1	.....	Attack	2	.....	.....	.....	.....	.....	.....	.....	2 GE J79 @ 10,000+ lb.t.
	T2J-1	.....	Trainer	2	36′	36′ 8″	14′ 9″	255	6,484	9,507	10,961	1 We. J34-WE-36, 46 @ 3,40
Northrop Aircraft, Inc.	F-89D	Scorpion	AW Interceptor	2	59′ 8″	53′ 9″	17′ 6″	600+	.....	.....	40,000+	2 All. J35-A-35 @ 5,600+ lb.
Hawthorne, Calif.	F-89H	Scorpion	AW Interceptor	2	59′ 8″	53′ 10″	17′ 6″	600+	.....	.....	.....	2 All. J35-A-35 @ 5,600+ lb.
	F-89J	Scorpion	AW Interceptor	2	59′ 8″	53′	17′ 6″	600+	.....	.....	.....	2 All. J35-A-35 @ 5,600+ lb.
	T-38	.....	Trainer	2	25′ 3″	43′	11′ 11″	.....	.....	.....	10,900	2 GE J85 @ 2,500 lb.t.
	.....	(N-165F)	Fighter	1	26′ 5″	41′ 7½″	13′	.....	.....	11,500	.....	2 GE J85 or Fair. J83
Republic Aviation Corp.	F-84F	Thunderstreak	Fighter-Bomber	1	33′ 6″	43′ 4″	14′ 4″	.....	.....	.....	25,000	1 Wr. J65-W-3 @ 7,200 lb.t.
Farmingdale, L.I., N.Y.	RF-84F	Thunderflash	Recon.	1	36′ 6″	47′ 6″	15′	.....	.....	.....	.....	1 Wr. J65-W-3 @ 7,200 lb.t.
	F-105B	Thunderchief	Fighter-Bomber	1	34′ 11″	63′ 11″	19′ 8″	.....	.....	.....	.....	1 P&W J75-P-3 @ 15,000+ l
Temco Aircraft Corp.	TT-1	Pinto	Trainer	2	29′ 10″	30′	10′ 10″	150	3,139	4,400	4,400	1 Con. J69-T-2 @ 920 lb.t.
Dallas, Tex.												
Chance Vought Aircraft, Inc.	F8U-1	Crusader	Day Fighter	1	35′ 8″	54′ 3″	15′ 9″	.....	.....	.....	.....	1 P&W J57-P-4A @ 10,000+
Dallas, Tex.	F8U-1P	Crusader	Recon.	1	35′ 8″	54′ 3″	15′ 9″	.....	.....	.....	.....	1 P&W J57-P-4A @ 10,000+
	F8U-2	Crusader	Day Fighter	1	35′ 8″	54′ 3″	15′ 9″	.....	.....	.....	.....	1 P&W J57-P-16 @ 10,000+
	F8U-3	.....	AW Fighter	1	.....	.....	.....	.....	.....	.....	.....	1 P&W J75 @ 15,000+ lb.t.

‡ Data is range in statute miles.

POWERPLANT		PERFORMANCE					ARMAMENT	CHRONOLOGY				REMARKS
Number, make, model and max. rating	Normal fuel cap., gal.	Maximum speed, mph.	Initial rate of climb, fpm.	Stall speed, dirty, mph.	Service ceiling, ft.	Combat radius, mi.	Number, type and designation	First flight of prototype	First production contract	First delivertes to service	First flight, first production article	
3 @ 225 hp. @ 920 lb.t.	50 180	189 295	1,230 1,440	54 65	20,000 25,000	.....	2 x .30 cal. mg.; 6 rockets	Dec. '48 Dec. '55	.....	Aug. '50	Oct. '53	Navy version is T-34B.
25 @ 6,000 lb.t.	.....	600+	.....	...	40,000+	1,500 +	? x 20 mm. cannon; 20,000 lb. bombs; GAM-63 Rascal	Dec. '47	Sept. '48	Oct. '51	June '50	Prod. discontinued Feb. '57.
1W @ 10,000+ lb.t.	.....	600+	.....	...	50,000+	.....	.....	Apr. '52	Feb. '51	June '54	Aug. '54	XB-52 contracted Jan. '47.
1W @ 10,000+ lb.t.	.....	600+	.....	...	50,000+	.....	.....	.....	Dec. '52	Nov. '55	Jan. '55	Also J57-P-29W; J57-P-19W.
19W @ 10,000+ lb.t.	.....	600+	.....	...	50,000+	.....	.....	.....	Dec. '53	Jan. '56	Mar. '56	Also J57-P-29W.
19W @ 10,000+ lb.t.	.....	600+	.....	...	50,000+	.....	.....	.....	Dec. '54	Nov. '56	Sept. '56	Also J57-P-29W.
19W @ 10,000+ lb.t.	.....	600+	.....	...	50,000+	.....	.....	.....	May '53	Oct. '57	Oct. '57	Also J57-P-29W.
43W @ 10,000+ lb.t.	.....	600+	.....	...	50,000+	.....	.....	.....	Aug. '56	June '58	June '58	
43W @ 10,000+ lb.t.	.....	600+	.....	...	50,000+	.....	.....	.....	Sept. '57	Oct. '58	Oct. '58	
@ 920 lb.t.	321	401	2,500	82	36,400	800[1]	.....	Oct. '54	July '54	Sept. '55	Sept. '55	Side-by-side seats.
@ 213 hp.	40	140	1,100	52	18,500	437[1]	.....	.....	.....	.....	.....	
@ 265 hp.	52	180	1,570	48	22,350	575	Bombs	.....	.....	.....	.....	
23 @ 10,000+ lb.t.	.....	M1+	.....	...	50,000+	.....	GAR-98 Falcons; 24 x 2.75-in. rockets	Oct. '53	.....	.....	.....	
23 @ 10,000+ lb.t.	.....	M1+	.....	...	50,000+	.....	.....	.....	.....	.....	.....	Side-by-side seats.
15,000+ lb.t.	.....	M2	.....	...	60,000+	.....	MB-1 Genie AAM	.....	.....	.....	.....	F-106B is tandem two-seater.
99W @ 2,500 hp.	1,550	300	1,370	92	24,000	.....	None	Sept. '49	.....	.....	.....	Some to get wingtip J44s.
53 @ 3,800 hp.;	30,000	435+	.....	...	45,000	5,000	16 x 20 mm. cannon; 10,000 lb.–84,000 lb. bombs	Aug. '46	Aug. '47	Aug. '47	Aug. '47	Quantities being scrapped.
-19 @ 5,200 lb.t.	.....	.....	.....	...	.....	.....	.....	.....	.....	.....	.....	
@ 10,000+ lb.t.	.....	M1.7	.....	...	50,000+	.....	.....	Nov. '56	.....	.....	.....	Delta wing.
(P&W)	.....	.....	.....	...	.....	.....	.....	.....	.....	.....	.....	Low budget, low priority.
@ 10,000 lb.t.	4,650	600+	.....	...	.....	.....	2 x 20 mm. cannon.	June '54	Aug. '53	June '55	Jan. '55	USAF model of Navy A3D.
@ 10,000 lb.t.	4,490	600+	.....	...	.....	.....	2 x 20 mm. cannon.	June '54	May '53	Apr. '55	Mar. '55	
@ 10,200 lb.t.	4,489	600+	.....	...	.....	.....	.....	.....	.....	.....	.....	
2,700 hp.	380	.....	.....	...	.....	.....	4 x 20 mm. cannon.	.....	.....	.....	.....	
10 @ 10,000+ lb.t.	.....	650+	.....	...	.....	.....	2 x 20 mm. cannon.	.....	.....	.....	.....	Also photo, ECM versions.
@ 7,200 lb.t.	.....	700+	.....	...	.....	.....	2 x 20 mm. cannon.	.....	.....	.....	.....	Cancelled A4D-3 had P&W J52.
10,000+ lb.t.	.....	M>1	.....	...	.....	.....	.....	.....	.....	.....	.....	
12 @ 10,000+ lb.t.	.....	M>1	.....	...	.....	.....	.....	.....	.....	.....	.....	Low production quantity.
8A @ 7,200 lb.t.	.....	650+	.....	...	.....	.....	2 x 20 mm. cannon.	.....	.....	.....	.....	
8 @ 7,200+ lb.t.	.....	M1+	.....	...	.....	.....	4 x 20 mm. cannon; Sidewinders	.....	.....	.....	.....	First U.S. area-ruled fighter.
-3 @ 10,000+ lb.t.	.....	1,000+	.....	...	55,000+	.....	4 x 20 mm. cannon.	.....	.....	.....	.....	Future versions would have J79-GE-7.
2 @ 1,525 hp.	.....	.....	.....	...	.....	.....	Sonobuoys, depth charges, missiles.	Dec. '52	.....	.....	.....	S2F-2 has enlarged bomb-bay.
2 @ 1,525 hp.	.....	.....	.....	...	.....	.....	None	Dec. '56	.....	Fall '57	Early '58	S2F mod. with 20' x 30' radome.
@ 1,005 eshp.	.....	.....	.....	...	.....	.....	.....	.....	.....	.....	.....	Army version is AO-1.
6A @ 1,425 hp.	1,275	.....	.....	...	.....	.....	None	.....	.....	.....	.....	High and low altitude operations.
8A @ 10,000+ lb.t.	.....	M1+	.....	...	60,000	.....	1 x Vulcan 20 mm. cannon.	Feb. '54	Oct. '54	.....	Feb. '56	Also F-104C and F-104D.
0,000+ lb.t.	.....	M1+	.....	...	.....	.....	.....	.....	.....	.....	.....	
3,250 hp.	7,750	300	.....	...	.....	.....	None	.....	.....	Dec. '53	.....	WV-2E is Navy model.
@ 5,200 lb.t.	813	600	4,680	100	46,000+	480	2 x 50-cal. mg.	Mar. '48	Oct. '47	Aug. '48	Sept. '48	Navy version is TV-2.
W @ 3,500 hp.+	.....	.....	.....	...	22,000	.....	6 x 20 mm. cannon.	May '45	.....	Apr. '54	.....	
3,400 lb.t.												
@ 6,100 lb.t.	760	600	6,330	97	40,000	.....	None	Dec. '54	.....	.....	Jan. '56	Boundary layer control flaps.
Vest. J34	.....	.....	.....	...	.....	.....	.....	.....	.....	.....	.....	Similar to 1649A.
10,000+ lb.t.	.....	.....	.....	...	55,000+	.....	None	.....	.....	.....	.....	High altitude studies.
(GE)	.....	.....	.....	...	.....	.....	.....	.....	.....	.....	.....	Studies include low-level subsonic jet.
@ 7,220 lb.t.	.....	600	.....	...	.....	.....	.....	Mar. '56	Mar. '55	May '56	Apr. '56	
W @ 3,400 hp.	2,815	250	1,200	90	24,000	700	2 x 20 mm. cannon.; 8 rockets	Aug. '53	May '52	June '54	Apr. '54	
,000 lb.t.	.....	600+	.....	...	40,000+	1,500	.....	July '55	.....	.....	.....	4 P&W J75 in production Seamasters.
3 @ 10,000+ lb.t.	.....	1,200+	.....	...	55,000+	.....	4 x 20 mm. cannon.	Sept. '54	Sept. '52	.....	Sept. '54	
5 @ 10,300+ lb.t.	.....	1,000+	.....	...	.....	.....	GAR-98 Falcons; 2 MB-1 Genie.	.....	.....	.....	.....	
3 @ 10,000+ lb.t.	.....	1,200+	.....	...	.....	.....	None	.....	.....	.....	.....	Holds three transcontinental speed records.
@ 10,000+ lb.t.	.....	.....	.....	...	.....	.....	.....	.....	.....	.....	.....	
hemical fuel	.....	M3	.....	...	.....	.....	.....	.....	.....	.....	.....	B-52 replacement.
7 @ 5,970 lb.t.	.....	650+	.....	...	45,000+	500+	6 x .50 cal. mg.; 16 x 5-in. HVAR.	.....	Dec. '57	.....	.....	
@ 9,000 lb.t.	.....	700	.....	...	45,000+	1,150	4 x 20 mm. cannon.	Apr. '53	.....	.....	Sept. '53	Or 6 x .50 cal. mg. armament.
3 @ 5,500 lb.t.	.....	650+	.....	...	45,000+	500+	4 x 20 mm. cannon.	July '54	.....	.....	.....	For NATO countries.
3 @ 7,650+ lb.t.	.....	700+	.....	...	.....	.....	.....	.....	.....	.....	.....	Many F-86D conversions.
@ 10,000+ lb.t.	.....	1,000+	.....	...	50,000+	500+	4 x 20 mm. cannon.	May '53	Mid-'53	Sept. '54	.....	
1 @ 10,000+ lb.t.	.....	1,000+	.....	...	50,000+	500+	4 x 20 mm. cannon.	Jan. '56	.....	Mid-'56	.....	
15,000+ lb.t.	.....	1,300+	.....	...	.....	.....	4 x 20 mm. cannon.	Sept. '56	.....	.....	.....	To NACA for high-speed research.
.....	.....	.....	.....	...	.....	.....	.....	.....	.....	.....	.....	Long-range.
60,000 lb.t.	.....	M5-7	.....	...	200-300 mi	.....	None	.....	.....	.....	.....	Pitch, roll, yaw control rockets.
1,425 hp.	.....	346	3,830	...	37,000	750	.50 cal. mg.; 2.25-in. rockets.	Sept. '55	Sept. '54	.....	.....	
200 lb.t.	.....	.....	.....	...	45,000	500+	4 x 20 mm. cannon.	July '53	.....	.....	.....	
A @ 7,700 lb.t.	.....	687	7,500	115	40,000+	.....	4 x 20 mm. cannon; Sidewinders.	Jan. '57	.....	.....	.....	
000+ lb.t.	.....	M2	.....	...	.....	.....	.....	.....	.....	.....	.....	
36, 46 @ 3,400 lb.t.	381	492	5,000	77	40,000+	.....	2 x .50 cal. mg.; 14 2.75-in. rockets.	Jan. '58	.....	.....	.....	First Columbus Division design.
@ 5,600+ lb.t.	.....	650+	.....	...	52,000+	.....	104 x 2.75-in. rockets.	Oct. '51	Apr. '51	Apr. '53	Jan. '53	Armament in wingtip pods.
@ 5,600+ lb.t.	.....	650+	.....	...	.....	.....	42 x 2.75-in. rockets; 6 x GAR-98	.....	.....	.....	.....	
@ 5,600+ lb.t.	.....	650+	.....	...	.....	.....	6 x GAR-98; 42 x 2.75-in. rockets, Genie	.....	.....	.....	.....	Earlier F-80s modernized.
00 lb.t.	.....	M1+	.....	...	.....	.....	.....	.....	.....	.....	.....	Or 2 Fairchild J83.
r. J83	.....	M1+	.....	...	.....	.....	2 x GAR-98 Falcons on wingtips.	.....	.....	.....	.....	T-38 fighter version.
@ 7,200 lb.t.	.....	650+	.....	...	45,000+	.....	6 x .50-cal. mg.; 24 x HVAR.	June '50	Apr. '51	Mar. '53	Nov. '52	Nose air intake.
@ 7,200 lb.t.	.....	650+	.....	...	45,000+	.....	4 x .50-cal. mg.	Feb. '52	Apr. '51	May '54	Sept. '53	Wing root air intakes.
@ 15,000+ lb.t.	.....	M1+	.....	...	.....	.....	.....	Oct. '55	.....	.....	.....	Also J75-P-5. Also F-105D and F-105E.
@ 920 lb.t.	124	325	1,900	73	30,000	276	None	Mar. '56	June '56	Nov. '57	Nov. '57	Tandem seats.
A @ 10,000+ lb.t.	.....	1,020	.....	...	.....	.....	4 x 20 mm. cannon; 32 x 2.75-in. rockets.	Mar. '55	.....	.....	Sept. '55	Also two Sidewinders.
A @ 10,000+ lb.t.	.....	1,000+	.....	...	.....	.....	.....	Dec. '56	.....	.....	.....	
8 @ 10,000+ lb.t.	.....	1,000+	.....	...	.....	.....	4 x 20 mm. cannon; 32 x 2.75-in. rockets.	.....	.....	.....	.....	Plus two Sidewinders.
5,000+ lb.t.	.....	M2	.....	...	.....	.....	.....	.....	.....	.....	.....	Also rocket power.

● SPECIFICATIONS

U. S. Personal and Business Aircraft

BASIC DATA		DIMENSIONS				WEIGHTS		POWERPLANT		PERFORMANCE				
Manufacturer and Address	Designation	No. of seats	Overall span	Overall length	Max. height, 3-pt.	Gross wing area, sq. ft.	Weight empty, lb.	Normal gross weight, lb.	Number, make, model and max. rating	Normal fuel capacity, gal.	Max. speed, mph.	Landing speed, mph.	CAA field length (takeoff), ft.	CAA field length (landing), ft.	Max. range, mi.	Price, FAF, $
Aerocar, Inc. *Longview, Wash.*	Aerocar	2 4	34′ 34′	21′ 21′	7′ 6″	190	1,500	2,050 2,000	1 Lyc. O320 @ 143 hp. 1 Lyc.	23.5	110+	50	650	350	300	25,000
Aero Design & Engr'g. Co. *Bethany, Okla.*	500E Commander 680 Commander Super Alti-Cruiser	8 8 5	49′ 44′ 44′	35′ 5″ 35′ 5″ 35′ 5″	14′ 6″ 14′ 9″ 14′ 9″	255 242 242	4,406 4,485	6,500 7,000 7,000	2 Lyc. GO 480-C1B6 @ 295 hp. 2 Lyc. GSO 480-B1A6 @ 340 hp. 2 Lyc. GSO 480-B1A6 @ 340 hp.	223 223 223	270 270 270	70 70 70	2,040 1,500 1,500	1,485 1,605 1,605	1,600 1,450 1,450	89,500 78,900 182,750
Aircraft Marine Engr'g Corp. *Van Nuys, Calif.*	A-1 Anser	9	46′	39′	11′	260	4,100	9,000	2 Con. 420-M @ 1,200 lb. t.	480	460	43	650	650	1,650	190,000
Baumann Aircraft Corp. *No. Hollywood, Calif.*	Brigadier B-290	5	41′	29′	11′	209	2,750	4,050	2 Con. C145-2HP @ 145 hp.	79	190	57	850	500	750	44,500
Bee Aviation Assoc., Inc. *San Diego, Calif.*	Wee Bee Honey Bee Queen Bee	1 1 4	18′ 28′ 32′ 10″	14′ 2″ 16′ 10″ 22′ 1″	5′ 7′ 8″ 8′ 6″	44 96 130	210 610 1,190	410 980 2,150	1 Kiek. O45-35 @ 30 hp. 1 Con. A65 @ 65 hp. 1 Lyc. O320 @ 150 hp.	2.5 8.8 44	82 120 175	45 45 55	500 700 700	500 500 700	50 240 650	 12,500
Beech Aircraft Corp. *Wichita, Kans.*	Super 18 (E18S) Bonanza J35 Twin-Bonanza: D50A F50 Travel Air 95 Paris MS-760	8 4 6 6 4 4	49′ 8″ 32′ 10″ 45′ 3″ 45′ 3″ 37′ 10″ 33′ 3″	35′ 2″ 25′ 2″ 31′ 6″ 31′ 6″ 25′ 4″ 33′	9′ 6″ 6′ 6″ 11′ 4″ 11′ 4″ 9′ 6″ 8′ 6″	361 178 277 277 194 194	6,050 1,820 4,090 4,460 2,580	9,300 2,900 6,300 7,000 4,000 7,725	2 P&W R985-AN14B @ 450 hp. 1 Con. IO470-C @ 250 hp. 2 Lyc. GO480-G2D6 @ 295 hp. 2 Lyc. GSO480-B1B6 @ 340 hp. 2 Lyc. O360-A1A @ 180 hp. 2 Turbo. IIC @ 893 lb. t.	275 39 134 180 112	234 206 214 240 209 303	57	1,800 670 71 80 70	1,700 400 1,260 1,250 1,025	1,626 1,060 1,455 1,840 950 1,000	106,975 24,300 77,000 88,000 49,500 210,000
Call Air *Afton, Wy.*	150 (Ag.) 180 (Ag.)	2 2	35′ 5″ 35′ 5″	23′ 9″ 24′	10′ 7′ 10″	186 186	1,020 1,170	2,150 2,350	1 Lyc. O320-A2A @ 150 hp. 1 Lyc. O360-A1A @ 180 hp.	25 40	110 115	43 46	750 750	400 400	325	7,881 .....
Cessna Aircraft Co, *Wichita, Kans.*	172 175 180 182 Skylane 310B	4 4 4 4 4 5	36′ 36′ 36′ 36′ 36′ 36′	25′ 24′ 26′ 26′ 26′ 27′	8′ 6″ 8′ 6″ 8′ 6″ 8′ 6″ 8′ 6″ 10′ 5″	175 175 175 175 175 175	1,200 1,312 1,555 1,560 1,560 2,965	2,200 2,350 2,650 2,650 2,650 4,700	1 Con. O300-A @ 145 hp. 1 Con. GO300-A @ 175 hp. 1 Con. O470-K @ 230 hp. 1 Con. O470-L @ 230 hp. 1 Con. O470-L @ 230 hp. 2 Con. O470-M @ 240 hp.	42 52 65 65 65 100	135 147 170 165 168 232	....	....	....	620 705 845 805 819 1,000	8,995 10,995 13,850 14,350 16,850 59,950
Champion Aircraft, Inc. *Osceola, Wisc.*	7EC Traveler 7FC Tri-Traveler 7GC Sky-Trac 7HC DX'er	2 2 3 3	35′ 2″ 35′ 2″ 35′ 2″ 33′	21′ 8″ 21′ 8″ 21′ 11″ 21′ 11″	5′ 2″ 7′ 2″ 6′ 2″ 7′	170 170 170 164	800 930 850 1,000	1,450 1,450 1,650 1,650	1 Con. C90-12F @ 95 hp. 1 Con. C90-12F @ 95 hp. 1 Lyc. O290-D2B @ 140 hp. 1 Lyc. O290-D2B @ 140 hp.	28 28 36 36	115 115 135 135	38 44 40 45	500 500 300 350	350 350 350 330	500 500 660 650	4,495 5,875 6,550 6,585
Clark Aircraft, Inc. *Marshall, Tex.*	Model 1000 Ag.	1	30′ 6″	24′ 11″	10′ 2″	305	2,144	3,520	1 Con. @ 220 hp.	46	100	40	.....	.....	.....	10,000
Colonial Aircraft Corp. *Sanford, Me.*	C-1 Skimmer C-2 Skimmer IV	3 4	34′ 34′	23′ 6″ 23′ 6″	8′ 10″ 9′	152 156	1,425 1,500	2,150 2,350	1 Lyc. O320 @ 150 hp. 1 Lyc. O360 @ 180 hp.	40 40	128 140	50 52	.....	.....	500 500	19,600 21,700
Fletcher Aviation *Rosemead, Calif.*	Utility	5	42′	31′ 10″	9′ 4″	294	1,870	3,500	1 Con. O470-E @ 225 hp.	44	.....	48	870	..	410	24,920
Forney Aircraft *Ft. Collins, Colo.*	F-1 Aircoupe	2	30′	20′ 2″	6′ 3″	143	900	1,400	1 Con. C90 @ 95 hp.	24	130	56	900	900	500	6,995
Grumman Aircraft Engrg. Corp. *Bethpage, L. I., N. Y.*	159 Gulfstream 164 Crop Duster	21 1	78′ 6″ 35′ 8″	64′ 24′ 4″	22′ 9″ 10′ 9″	615 326	19,680 2,179	31,000 3,600	2 R-R Dart 7/2 @ 2,105 eshp. 1 Con. R760 @ 220 hp.	8,900 34	370 115	 40	....	....	2,200 300	700,000 18,000*
Helio Aircraft Corp. *Norwood, Mass.*	Courier Strato-Courier	5 2	39′ 39′	30′ 30′	8′ 10″ 8′ 10″	231 231	1,920 2,080	3,000 3,500	1 Lyc. GO435-C2B2 @ 260 hp. 1 Lyc. GSO480-A2A6 @ 340 hp.	60 82	169 194	30 30	495 320	495 495	700 975	27,650 .....
Lockheed Aircraft Corp. *Marietta, Ga.*	329 Jetstar	20	53′ 8″	58′ 10″	20′ 6″	523	14915	28000	4 GE JS5 @ 2,500 lb. t.; 2 Wr. TJ37A-1 @ 4,850 lb. t.	1,640	555	103	3,420	5,250	1,778	800,000
Mooney Aircraft, Inc. *Kerrville, Tex.*	Mark 20 Mark 20-A Mark 22	4 4 4	35′ 35′ 35′	23′ 2″ 23′ 23′	8′ 5″ 8′ 5″ 8′ 5″	167 167 167	1,450 1,450 1,950	..... 2,450 3,250	1 Lyc. O320 @ 150 hp. 1 Lyc. O360-A1A @ 180 hp. 2 Lyc. O320 @ 150 hp.	50 49 100	177 195 220	57 57	....	....	1,000 1,000 1,400	13,750 14,750 27,500
On Mark Engr'g. Co. *Van Nuys, Calif.*	Marksman 480	14	77′ 3″	64′ 3″	21′ 12″	.....	23,000	40,000	2 All. 501D-13/15 @ 4,000 eshp.	2,100	450*	...	4,170	2,200	3,100	1,180,000
Piper Aircraft Corp. *Lock Haven, Pa.*	PA-18 "95" PA-18 "150" PA-18A Super Cub PA-22 "150" Tri-Pacer PA-22 "160" Tri-Pacer PA-23 "150" Apache PA-23 "160" Apache PA-24 "180" Comanche ..... Aztec	2 2 1 4 4 4 4-5 4	35′ 3″ 35′ 3″ 35′ 3″ 29′ 3″ 29′ 3″ 37′ 37′ 36′	22′ 5″ 22′ 5″ 22′ 5″ 20′ 6″ 20′ 6″ 27′ 1″ 27′ 1″ 24′ 8″	6′ 7″ 6′ 7″ 6′ 7″ 8′ 3″ 8′ 3″ 9′ 5″ 9′ 5″ 7′ 4″	178.5 178.5 178.5 147.5 147.5 204 204 178	800 930 1,060 1,100	1,500 1,750 2,070 2,000 2,000 ..... 3,500 2,550 4,700*	1 Con. C90 @ 90 hp. 1 Lyc. O320 @ 150 hp. 1 Lyc. O320 @ 150 hp. 1 Lyc. O320 @ 150 hp. 1 Lyc. O320-B @ 160 hp. 2 Lyc. O320 @ 150 hp. 2 Lyc. O320-B @ 160 hp. 1 Lyc. O360-A1A @ 180 hp. 2 Lyc. O540 @ 250 hp.	18 36 36 36 36 72 72 50	112 130 105 139 141 180 183 167	42 43 45 49 49 82 61 58	750 500 950 1,220 900 ..... 1,190 750	800 725 875 500 ..... 670 750 600	360 460 360 500 535 800 940 920	5,695 7,150 7,335 8,395 8,595 34,990 35,990 14,500 .....
Rawdon Bros. Aircraft, Inc. *Wichita, Kans.*	T-1 Trainer T1-8D Ag.	2 1	35′ 35′	24′ 4″ 24′ 4″	6′ 11″ 6′ 11″	176 176	1,300 1,340	1,900 2,550	1 Lyc. O320-A2A @ 150 hp. 1 Lyc. O320-A2A @ 150 hp.	38 38	.....	.....	.....	.....	.....	.....
Stits Aircraft *Riverside, Calif.*	SA9A Skycoupe	2	28′ 4″	17′ 6″	.....	125	695	1,250	1 Con. C90-12F @ 95 hp.	24	145	...	350	400	500	4,500
Taylorcraft, Inc. *Conway, Pa.*	Zephyr Topper Seabird	4 1 4	34′ 8″ 34′ 8″ 34′ 8″	24′ 4″ 24′ 4″ 24′ 4″	7′ 2″ 7′ 2″ 7′ 2″	179 179 179	1,700 1,635 2,000	2,750 2,750 3,040	1 Con. O470J @ 225 hp. 1 Con. O470J @ 225 hp. 1 Con. O470J @ 225 hp.	66 46 66	160 115 145	65 70 70	450 900 700	700 900 1,000	750 400 650	13,945 13,990
Transland Aircraft *Torrance, Calif.*	Ag-2	1	42′	28′ 5″	9′ 8″	321	3,382	6,000	1 P&W R1340 @ 600 hp.	125	144	51	900	600	.....	28,500
Trocker Aircraft Corp. *Milwaukee, Wisc.*	Gull L-1 Super Gull L-2	5 5	44′ 5″ 44′ 5″	35′ 7″ 35′ 7″	12′ 7″ 12′ 7″	270 270	4,400 4,630	6,000 6,393	2 Lyc. GO480-B @ 270 hp. 2 Lyc. GSO480-B2C6 @ 340 hp.	190 190	182 208	75 82	1,360 1,400	1,630 1,750	990 900	74,500 89,925

Abbreviations:
All. — Allison Division, GMC
Con. — Continental
GE — General Electric
Kiek. — Kiekhaefer
Lyc. — Lycoming Division, Avco
P&W — Pratt & Whitney Aircraft Division, UAC
R-R — Rolls-Royce
Turbo. — Turbomeca
Wr. — Wright Aeronautical Corp.

* — Approximate
! Price minus engines.
Landing and takeoff distance data supplied by manufacturers; in some cases, figures appear to be only rolling distances on the ground.

U.S. Civil and Military Rotary-Wing Aircraft

General Data						Dimensions			Weights			Powerplant		Performance			Remarks
Manufacturer	Model No.	Military Designation	No. of Crew	No. of Passengers	Cargo Capacity, lbs.	Rotor Dia., ft.	Max. Length (Blades Unfolded) ft.	Overall Height To Top of Rotor, ft.	Weight Empty lbs.	Normal Gross Wt., lbs.	Max. Gross Wt., lbs.	Manufacturer and Designation	Max. Rating h.p. or ehp. per Engine	Max. Speed, mph. at Altitude, ft.	Hovering Ceiling In Ground Effect, ft.	Normal Still-Air Range, mi.	
Bell Aircraft Corp.	XV-3	.....	1	.....	.....	25' 0"	30' 0"	13' 6"	3,490	.....	4,700	1 P&W R985	450	184 @ 2,500	7,400	480	R&D
	47G	Sioux	1	2	465	35' 1"	41' 5"	9' 5"	1,435	.....	2,350	1 AM 6V4-200-C32	200	86 S.L. to 1,400	3,600	212	Commercial, Recon & Training
	47-J	Ranger	1	3	546	37' 2"	43' 4"	9' 4"	1,615	.....	2,565	1 Lyc. VO-435	220	105 S.L. to 7,000	7,400	200	Also certified in 2800 lb. G.W. Configuration
	47H	Bellairus	1	2	459	35' 1"	41' 3"	9' 3"	1,499	.....	2,350	1 AM 6V4-200-C32	200	98 S.L. to 1,400	4,300	211	Commercial
	47G-2	Sioux	1	2	431	35' 1"	41' 5"	9' 5"	1,564	.....	2,450	1 Lyc. VO-435	200	100 S.L. to 1,400	10,850	238	Coml., Recon.
	UH-1A	Iroquois	1	5	903	44' 0"	53' 0"	11' 3"	3,791	.....	5,800	1 Lyc. T-53	700	151	14,400	260	Utility (XH-40)
	HTL-7	.....	1	1	.....	37' 2"	43' 4"	9' 4"	1,835	.....	2,565	1 Lyc. O-435-6	220	103	8,200	154	Instrument Trainer
Benson Aircraft Corp.	B-7	.....	1	0	125	20' 0"	20' 0"	5' 10"	95	270	395	None	...	90 @ S.L.	.....	...	Gyroglider, Sport & Training
	B-7W	.....	1	0	90	20' 0"	20' 0"	7' 8"	130	305	400	None	...	60 @ S.L.	.....	...	Hydroglider, Sport & Training
	B-7M	.....	1	0	30	20' 0"	20' 0"	5' 10"	180	385	450	1 Nelson H-59A	42	80 @ S.L.	.....	120	Gyrocopter, Recon, Sport, Liaison
	B-8M	.....	1	0	75	21' 0"	21' 0"	6' 4"	250	550	600	1 McC. 4318E	72	85 @ S.L.	.....	130	Gyrocopter, Recon, Sport, Liaison
Brantly Helicopter Corp.	B-2	.....	1	1	350	23 8	27 8	6 98	980	1,600	1,600	1 Brantly	172	100 @ S.L.	4,000	270	Utility & Personal
Cessna Aircraft Corp.	CH-1	YH-41	1	1	400	35' 0"	42' 6"	8' 6"	2,045	3,000	3,000	1 Con. FSO470	260	122 @ S.L.	13,200	290	
Convertawings, Inc.	A	.....	1	0	.....	19 4	35 5	.....	.....	.....	2,000	2 Con. C-90	95	.....	.....	...	Quadrarotor test bed
Daman Helicopters, Inc.	LZS-1	YH-31	1	7	1,400	48' 0"	58' 9"	10' 5"	3,387	5,200	5,200	1 Lyc. SO580-A1B	400	76 @ 1,000	4,000	350	
	LZS-2	.....	1	7	1,400	48' 0"	58' 9"	10' 5"	3,250	5,200	5,200	1 Lyc. SO580-A1B	400	105 @ 1,000	4,000	380	
	D-11	.....	1	7	1,800	48' 0"	58' 9"	10' 5"	3,136	5,200	5,200	1 Lyc. SO580-A1B	400	105 @ 1,000	4,000	380	
Goodyear Aircraft Corp.	400R	.....	1	0	.....	.....	.....	.....	275	475	520	1 JM RDHE	35	60 @ S.L.	.....	50	Prototype
Gyrodyne Co. of America, Inc.	XRON-1	.....	1	0	.....	17' 0"	17' 0"	7' 3"	381	645	700	1 Porsche 1600 c.c.	60	73 @ S.L.	6,000	27	Rotorcycle, Obs. & Liaison
Hiller Helicopters	UH12-C	.....	1	2	370	35' 0"	40' 6"	9' 6"	1,737	2,500	2,500	1 AMGV-335-B	210	87 @ S.L.	2,500	104	
	H-23D	Raven	1	2	407	35' 6"	40' 6"	10' 1"	1,780	2,700	2,850	1 Lyc. VO-435-A1C	250	95 @ S.L.	5,200	205	
	XROE-1	.....	1	0	.....	18' 6"	18' 6"	7' 5"	270	526	.....	1 Nelson H59	40	70 @ S.L.	5,800	27	
Hughes Aircraft Div.	269A	.....	1	1	.....	25' 0"	25' 0"	8' 0"	850	1,500	.....	1 Lyc. O390-C2A	180	95 @ S.L.	7,000	170	
Kaman Aircraft Corp.	HOK-1	.....	3	3	2,000	47' 0"	47' 0"	11' 10"	.....	5,800	6,800	1 P&W R-1340	600	110 @ 8,000	12,000	220	
	HUK-1	.....	2	3	2,000	47' 0"	47' 0"	11' 10"	.....	5,800	6,800	1 P&W R-1340	600	110 @ 8,000	12,000	220	
	H-43A	.....	2	3	2,000	47' 0"	47' 0"	11' 10"	.....	5,800	6,800	1 P&W R-1340	600	110 @ 8,000	12,000	220	
	H-43B	.....	2	6	2,000	47' 0"	47' 0"	11' 10"	.....	.....	.....	1 Lyc. T-53	825	.....	.....	...	
	HU2K-1	.....	...	...	...	...	...	...	.....	.....	.....	1 GE. T-58	1,050	.....	.....	...	
	HTK-1	.....	...	...	...	41' 0"	41' 0"	12' 3"	.....	.....	.....	1 Lyc. O-435	245	.....	.....	...	Robot development project
Kellett Aircraft Corp.	KH-15	.....	1	0	.....	.....	.....	.....	.....	.....	.....	2 RMI Rockets	16[1]	.....	.....	...	Research vehicle
	KH-17A	.....	1	0	.....	.....	.....	.....	.....	.....	.....	1 Jac. R755B and 2 Lyc. O290-D2	.....	.....	.....	...	Flying test bed
McDonnell Aircraft Corp.	XV-1	.....	1	2	212	31' 0"	31' 0"	10' 9"	4,277	5,505	.....	1 Con. R957-19	550	170 @ S.L.	7,500	305	Convertiplane
Nagler Helicopter Co., Inc.	160	.....	1	0	.....	20' 3"	.....	.....	.....	750	.....	1 McC. 4318	70	90 @ S.L.	6,000	...	Co-axial test vehicle
Omega Aircraft Co.	BS-12	.....	1	4	1,050	39' 0"	39' 6"	13' 0"	3,125	4,565	4,560	2 AM 6A-335-A	225	103 @ S.L.	4,800	270	
	BS-14	Falcon	1	1	.....	24' 0"	25' 6"	9' 0"	1,350	2,000	.....	1 AM 6V-335-A	225	.....	.....	...	
Piasecki Aircraft Corp.	PiAC-59K	Aer. Jeep	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	Fairey Ultra-light	.....	1	1	843	28' 3"	28' 3"	8' 2"	980	1,800	1,800	1 Blackburn-Turbomeca Palouste	250 air hp	95	10,200	185	U.S. Sales Rep.
Republic Aviation Corp.	Alouette	.....	1	4	1,080	33' 0"	31' 10"	9' 0"	1,830	3,000	3,000	1 Turbo. Artouste IIB-1	400	105 @ 14,500	15,500	325	Under license from Sud Aviation
Rotor Craft Corp.	RH-1	.....	1	0	50+	18'	7' 6"	8'	180	400+	.....	RC. R-1	25[1]	80	12,000	30	Rocket power
Sikorsky Aircraft Div.	S-55C	H-19A	1-2	10	1,700	53' 0"	62' 7"	13' 4"	4,888	7,200	7,200	1 P&W R1340	600	101 @ S.L.	2,200	405	Also H-19C, HO4S-1, HRS-1& 2
	S-55A	H-19B	1-2	10	2,100	53' 0"	62' 7"	13' 4"	5,188	7,900	7,500	1 Wr. R1300-3	700	110 @ S.L.	8,500	395	Also H-19D, HO4S-2 HO4S-3, HR2-3
	S-56	HR2S-1	2	...	9,149	72' 0"	82' 10"	17' 1"	20,455	28,500	31,000	2 P&W R2800-50	1,900	140 @ S.L.	.....	...	Also H-37A
	S-58	H-34A	2-4	18	4,000	56' 0"	65' 10"	14' 4"	7,650	12,500	13,300	1 Wr. R1820-84	1,525	134 @ S.L.	10,000	384	Also HSS-1
	S-59	XH-39	1-2	2-3	800	35' 0"	41' 7"	9' 8"	2,200	3,625	3,625	1 Con. Artouste II	425	146 @ S.L.	18,500	288	
	S-61	.....	...	...	...	50' 0"	.....	.....	.....	.....	.....	2 GE. T-58	1,900	.....	.....	...	
	S-62	.....	...	...	...	53' 0"	62' 7"	13' 4"	.....	.....	.....	1 GE. T-58	1,050	.....	.....	...	
Transcendental Aircraft Corp.	1-G	.....	1	.....	.....	17' 0"	.....	.....	.....	.....	.....	1 Lyc. GO-290	160	.....	.....	...	Convertiplane test
Vertol Aircraft Corp.	PD-18	HUP-2	1	5-6	1,500	35' 0"	56' 11"	13' 2"	4,100	5,750	6,100	1 Con. R975-46	550	108 @ S.L.	7,000	490	
	PD-18	H-25A	1	5-6	1,500	35' 0"	56' 11"	12' 6"	3,928	5,750	6,100	1 Con. R975-46	550	108 @ S.L.	7,000	490	Also HUP-3
	.....	HUP-4	1	...	...	...	...	...	...	...	...	1 Wr. R1300-3	700	.....	.....	...	
	.....	H-21A	1-2	14	.....	44' 0"	86' 4"	16' 0"	8,300	11,200	14,500	1 Wr. R1820-103	1,150	140 @ S.L.	14,900	450	
	143	H-21B	1-2	20	.....	44' 0"	86' 4"	16' 0"	8,600	13,300	15,000	1 Wr. R1820-103	1,425	140 @ S.L.	6,000	400	
	143	H-21C	1-2	20	1,500	44' 0"	86' 4"	16' 0"	8,600	13,300	15,000	1 Wr. R1820-103	1,425	140 @ S.L.	6,100	400	
	H-21D	.....	2	20	.....	44' 0"	.....	.....	8,611	14,700	.....	2 GE. T-58	1,024	140 @ S.L.	.....	...	Experimental
	105	.....	2	20	.....	44' 0"	.....	.....	8,750	14,700	.....	2 Lyc. T-53	825	140 @ S.L.	.....	...	Experimental
	76	.....	...	...	...	...	...	...	...	...	...	1 Lyc. T-53	825	.....	.....	...	Research craft
	44	.....	2	15-19	5,420	44' 0"	.....	.....	8,980	14,300	.....	1 Wr. 1820	1,425	110	4,900	...	Commercial transport

Abbreviations:
AM—Aircooled Motors (Franklin)
Con.—Continental
GE—General Electric
Jac.—Jacobs
JM—Johnson Motors
Lyc.—Lycoming
McC.—McCulloch Motors
P&W—Pratt & Whitney Aircraft
RC.—Rotor Craft
Wr.—Wright

Footnote: [1] pounds thrust

GENERAL					STATUS				AIRFRAME				
Category	Missile name	Military designation	Cognizant service	Prime contractor	Research	Development	Production	Service Use	Manufacturer	Overall length, less booster, ft.	Overall span, wings or fins, ft.	Body diameter, ft.	Launching wt., less booster, lb.
Satellite Vehicles	Jupiter-C	.....	ArmyOrd	ABMA	..	..	..	√	.....	69	....	5.8	64,000
	Vanguard	.....	NRL	Martin	..	..	..	√	Martin	72	....	3.8	22,000
	Pied Piper	WS-117-L	USAF	Lockheed	√	..	..	..	.....	....	....	....	.....
Test Vehicles	.....	X-7	USAF	Lockheed	..	..	..	√	Lockheed	....	....	....	.....
	.....	X-17	USAF	Lockheed	..	..	..	√	Lockheed	40	....	....	.....
	Cherokee	.....	USAF	Cook El.	..	√	..	..	.....	25	....	4.2	4,500
	Skokie I	.....	USAF	Cook El.	..	..	..	√	.....	25	....	1.7	2,400
Research Vehicles	Arcon	.....	NRL	Atlantic	..	√	..	..	.....	11.1	....	0.5	250
	Iris	.....	NRL	Atlantic	..	√	..	..	.....	16.3	....	....	.....
	Harp	.....	Navy	.....	..	..	..	√	.....	6	....	0.3	.....
	Aerobee	AJ10-25	Army-Navy-USAF	Aerojet	..	..	..	√	Aerojet	19	....	1.3	.....
	Aerobee-Hi	AJ11-6	Navy-USAF	Aerojet	..	..	..	√	Aerojet	21	....	1.3	.....
	Deacon	.....	NACA	ABL	..	..	..	..	.....	9.2	....	0.5	153
	Cajun	.....	USAF	U. of Mich.	..	..	..	√	.....	13.3	3	0.5	254
	Asp	.....	Navy	Cooper	..	..	..	√	Cooper	12	1.7	0.5	245
	Rockaire	.....	USAF	Douglas	..	√	..	..	.....	8.9	1.7	0.8	181
	Rockair	.....	Navy	.....	..	..	..	√	.....	4	....	0.2	18
	Terrapin	.....	.....	Republic-U. of Md.	..	..	..	√	Republic	14.8	2.2	0.5	224
	HTV	.....	USAF	ADC	..	..	√	..	.....	13	....	0.8	220
	Wasp	.....	Navy	Cooper	..	..	..	√	Cooper	....	....	....	.....
	Farside	.....	USAF	Aeronutronic	..	..	..	√	.....	30	....	8	1,900

Abbreviations:
ABL — Allegany Ballistics Labe
ABMA — Army Ballistic Missile Agency
AC — AC Spark Plug
ADC — Aerophysics Development Corp.
APL — Applied Physics Laboratory
Army Ord — Army Ordnance
BuAer — Bureau of Aeronautics
BuOrd — Bureau of Ordnance
Con. — Continental
ECM — Electronic countermeasures
F'child A D — Fairchild Aircraft Division
F'child E D — Fairchild Engine Division
F'child GMD — Fairchild Guided Missile Division
FTL — Federal Telecommunications Laboratory
GCC — Ground controlled command
GE — General Electric
GFE — Government furnished equipment

U. S. Drones

GENERAL					STATUS				AIRFRAME				
Category	Missile name	Military designation	Cognizant service	Prime contractor	Research	Development	Production	Service Use	Manufacturer	Overall length, less booster, ft.	Overall span, wings or fins, ft.	Body diameter, ft.	Launching wt., less booster, lb.
	Firebee	Q-2A	USAF	Ryan	..	..	√	√	Ryan	17.3	11.1	....	1,849
	Firebee	KDA-1	Navy	Ryan	..	..	√	√	Ryan	17.7	11.1	....	1,900
	.....	SD-3	Army	Republic	√	√	√	..	Republic	....	....	....	.....
	.....	.....	Army	F'child AD	..	√	..	..	.....	....	....	....	.....
	.....	SD-1	Army	Radioplane	..	..	√	..	Radioplane	13.1	13.1	1	375
	.....	RP-76	Army	Radioplane	..	..	√	..	Radioplane	9.7	5	1.3	300
	Teal	XKDT-1	Navy	Temco	..	√	..	..	Temco	11.8	4.9	.8	.....
	.....	XQ-4	USAF	Radioplane	..	√	..	..	Radioplane	35	12	2	.....
	.....	RP-77DL	Army	Radioplane	..	√	..	..	Radioplane	14.8	21	2	326
	(1001)	XKDB-1	Navy	Beech	..	..	..	..	.....	13.5	12.5	....	600
	(1012)	.....	.....	Beech	..	..	..	..	.....	....	....	....	800

	Launching wt., less booster, lb.	POWERPLANT: Manufacturer	POWERPLANT: No. of engines	POWERPLANT: Engine designation	POWERPLANT: Rated thrust, lb.	GUIDANCE: Manufacturer	GUIDANCE: Type of guidance	PERFORMANCE: Maximum Mach number	PERFORMANCE: Maximum range, mi.	REMARKS
S	64,000	NAA JPL	1 15	lpr. spr.	84,000	.....	.....	.....	.....	Four-stage carrier for Explorer satellite; first stage a modified Redstone; latter stages scaled-down Sergeant rockets.
8	22,000	GE Aerojet Gr.Central	1 1 1	lpr. lpr. spr.	27,000 7,500	M-H	Inertial	.....	.....	Three-stage carrier for NRL satellite.
.	.....	.....	..	.....	.....	.....	.....	.....	.....	Recon. satellite.
.	.....	.....	1	rj.	.....	.....	.....	.....	.....	Ramjet engine testbed.
.	.....	Thiokol	5	spr.	.....	.....	.....	.....	.....	Three-stage re-entry vehicle.
2	4,500	.....	1	spr.	50,000	.....	None	1.5	.....	Air-launched ejection seat test vehicle
7	2,400	.....	3	spr.	33,000	.....	.....	.....	.....	Air-launched parachute test vehicle; Skokie II is Mach 2 version
5	250	.....	1	spr.	.....	.....	.....	.....	.....	Sounding rocket; 40-lb. payload to 70 mi.
.	.....	.....	..	spr.	.....	.....	.....	.....	.....	Sounding rocket; 100-lb. payload to 200 mi.
3	.....	Gr.Central	1	spr.	.....	.....	.....	.....	.....	Formerly Loki; weather rocket; 20-mi. alt.
3	.....	Aerojet	1	lpr.	4,000	.....	.....	.....	.....	Sounding rocket; 150-lb. payload to 70 mi.
3	.....	Aerojet	1	lpr.	4,100	.....	.....	.....	.....	Sounding rocket; 150-lb. payload to 170 mi.
5	153	ABL	1	spr.	.....	.....	.....	.....	.....	Sounding rocket.
5	254	Thiokol	1	spr.	8,300	.....	.....	6.5	.....	Sounding rocket.
5	245	Gr. Central	1	spr.	5,850	.....	.....	.....	.....	Sounding rocket; 25-lb. payload to 38 mi.
1	181	.....	1	DM-16 Jato	7,800	.....	.....	.....	.....	Air-launched sounding rocket; 40-lb. payload
2	18	.....	1	spr.	.....	.....	.....	.....	.....	2.75-in. FFAR rockets instrumented for sounding experiments
.	224	Thiokol/ABL	2	spr.	.....	.....	.....	.....	.....	Sounding rocket; 6.5-lb. payload to 76 mi.
.	220	.....	11	spr.	.....	.....	.....	7	.....	Two-stage hypersonic test vehicle
.	.....	Gr.Central	..	spr.	.....	.....	.....	.....	.....	Weather-sounding vehicle.
.	1,900	Thiokol/GC	10	spr.	.....	.....	.....	.....	.....	Balloon-launched; 3.5-lb. payload to 4,000 mi.

le Division
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uipment

Gr. Central — Grand Central Rocket Co.
ICBM — Intercontinental ballistic missile
IRBM — Intermediate range ballistic missile
JPL — Jet Propulsion Laboratory
lpr — liquid-propellant rocket
M-H — Minneapolis-Honeywell

MIT — Mass. Institute of Technology
NOTS — Naval Ordnance Test Station
NAA — North American Aviation
N.C. — Nuclear capability
No — Northrop
NRL — Naval Research Laboratory

R-R — Rolls-Royce
RMI — Reaction Motors, Inc.
Stell. Inert. — Stellar-inertial
tj — turbojet
WeEl — Western Electric
° — Approximate
[1] Gross takeoff weight

	Launching wt., less booster, lb.	POWERPLANT: Manufacturer	POWERPLANT: No. of engines	POWERPLANT: Engine designation	POWERPLANT: Rated thrust, lb.	GUIDANCE: Manufacturer	GUIDANCE: Type of guidance	PERFORMANCE: Maximum Mach number	PERFORMANCE: Maximum range, mi.	REMARKS
	1,849	Con.	1	J69-T-19A	1,000	GFE	Radio/radar	.85	.....	Target; Army XM-21
	1,900	F'child	1	J44-R-20	1,000	GFE	Radio	.85	.....	Target
	.....	.....	1	.....	.....	.....	.....	.....	.....	Surveillance
	.....	.....	..	.....	.....	.....	.....	.....	.....	Surveillance
	375	McCulloch	1	4 cylinder	.....	Radioplane	Radio	.....	540	Also RP-71F; surveillance
	300	Aerojet	1	spr.	35	Radioplane	Autopilot	.95	80	Target; Navy XKD4R-1
	.....	Phillips	1	spr.	.....	Temco	Preset	.95	.....	Air-launched target
	.....	R-R	1	Soar tj.	.....	Radioplane	Radar	.....	400	Supersonic target
	326	Boeing	1	502-210 tp.	.....	Radioplane	Radio	.6	540	Plastic drone-launcher
	600	McCulloch	1	120-hp.	.....	.....	.....	.....	.....	Target
	800	McCulloch	1	110-hp.	.....	.....	.....	.....	.....	Surveillance; heavier XKDB-1

POWERPLANT				GUIDANCE		PERFORMANCE		
Manufacturer	No. of engines	Engine designation	Rated thrust, lb.	Manufacturer	Type of guidance	Maximum Mach number	Maximum range, mi.	REMARKS
NAA JPL	1 15	lpr. spr.	84,000	.....	.....	.....	.....	Four-stage carrier for Explorer satellite; first stage a modified Redstone; latter stages scaled-down Sergeant rockets.
GE Aerojet Gr.Central	1 1 1	lpr. lpr. spr.	27,000 7,500	M-H	Inertial	.....	.....	Three-stage carrier for NRL satellite.
.....	..	.....	.....	.....	.....	.....	.....	Recon. satellite.
.....	1	rj.	.....	.....	.....	.....	.....	Ramjet engine testbed.
Thiokol	5	spr.	.....	.....	.....	.....	.....	Three-stage re-entry vehicle.
.....	1	spr.	50,000	.....	None	1.5	.....	Air-launched ejection seat test vehicle
.....	3	spr.	33,000	.....	.....	.....	.....	Air-launched parachute test vehicle; Skokie II is Mach 2 version
.....	1	spr.	.....	.....	.....	.....	.....	Sounding rocket; 40-lb. payload to 70 mi.
.....	..	spr.	.....	.....	.....	.....	.....	Sounding rocket; 100-lb. payload to 200 mi.
Gr.Central	1	spr.	.....	.....	.....	.....	.....	Formerly Loki; weather rocket; 20-mi. alt.
Aerojet	1	lpr.	4,000	.....	.....	.....	.....	Sounding rocket; 150-lb. payload to 70 mi.
Aerojet	1	lpr.	4,100	.....	.....	.....	.....	Sounding rocket; 150-lb. payload to 170 mi.
ABL	1	spr.	.....	.....	.....	.....	.....	Sounding rocket.
Thiokol	1	spr.	8,300	.....	.....	6.5	.....	Sounding rocket.
Gr. Central	1	spr.	5,850	.....	.....	.....	.....	Sounding rocket; 25-lb. payload to 38 mi.
.....	1	DM-16 Jato	7,800	.....	.....	.....	.....	Air-launched sounding rocket; 40-lb. payload
.....	1	spr.	.....	.....	.....	.....	.....	2.75-in. FFAR rockets instrumented for sounding experiments
Thiokol/ABL	2	spr.	.....	.....	.....	.....	.....	Sounding rocket; 6.5-lb. payload to 76 mi.
.....	11	spr.	.....	.....	.....	7	.....	Two-stage hypersonic test vehicle
Gr.Central	..	spr.	.....	.....	.....	.....	.....	Weather-sounding vehicle.
Thiokol/GC	10	spr.	.....	.....	.....	.....	.....	Balloon-launched; 3.5-lb. payload to 4,000 mi.

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Stell. Inert. — Stellar-inertial
tj — turbojet
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* — Approximate
† Gross takeoff weight

POWERPLANT				GUIDANCE		PERFORMANCE		
Manufacturer	No. of engines	Engine designation	Rated thrust, lb.	Manufacturer	Type of guidance	Maximum Mach number	Maximum range, mi.	REMARKS
Con.	1	J69-T-19A	1,000	GFE	Radio/radar	.85	.....	Target; Army XM-21
Fchild	1	J44-R-20	1,000	GFE	Radio	.85	.....	Target
.....	1	.....	.....	.....	.....	.....	.....	Surveillance
.....	..	.....	.....	.....	.....	.....	.....	Surveillance
McCulloch	1	4 cylinder	.....	Radioplane	Radio	.....	540	Also RP-71F; surveillance
Aerojet	1	spr.	35	Radioplane	Autopilot	.93	80	Target; Navy XKD4R-1
Phillips	1	spr.	.....	Temco	Preset	.95	.....	Air-launched target
R-R	1	Soar tj.	.....	Radioplane	Radar	.....	400	Supersonic target
Boeing	1	502-210 tp.	.....	Radioplane	Radio	.6	540	Plastic drone-launcher
McCulloch	1	120-hp.	.....	.....	.....	.....	.....	Target
McCulloch	1	110-hp.	.....	.....	.....	.....	.....	Surveillance; heavier XKDB-1

Leading Foreign Aircraft, Military and Civil

Manufacturer	Model designation	Aircraft name	Primary mission	Min. No. of crew	Max. No. of passengers	Overall wingspan, ft.	Overall length, ft.	Maximum height, ft.	Wing gross area, sq. ft.	Weight empty, lb.	Gross weight, lb.	Number, make, model and max. rating of powerplants	Max. speed, mph.
ARGENTINA													
Fabrica Militar de Aviones	I.A. 33	Pulqui II	Fighter	1	0	34' 9"	38'	10' 10"	270	7,920	12,210	1 R-R Nene @ 5,000 lb. t.	646
Cordoba	I.A. 35	Huanquero	Multi	3	8	61' 3"	45' 10"	13' 8"	455	7,700	13,700	2 F.M.A. Indio I.A. 19 @ 690 hp.	225
	I.A. 45	.....	Personal	1	3-4	44' 6"	29'	9' 2"	205	2,426	3,670	2 Lyc. O-320 @ 150 hp.	178
	I.A. 46	.....	Utility	1	2	38' 7"	24' 11"	7' 3"	194	1,213	2,204	1 Lyc. O-320 @ 150 hp.	121
AUSTRALIA													
Commonwealth Aircraft Corp. Pty., Ltd.	C.A. 25	Winjeel	Trainer	3	0	38' 9"	28'	9'	240	3,280	4,225	1 P&W R985-AN 2 @ 450 hp.	187
Lorimer Street, Port Melbourne, Victoria	C.A. 27	Sabre Mk. 30	Fighter	1	0	37' 1"	37' 6"	14' 8"	288	11,000	20,000	1 R-R Avon 20 @ 7,500 lb.t.	700
	C.A. 28	Ceres	Utility	1	0	47'	30' 3"	9'	312	4,000	7,000	1 P&W Wasp S2H1-G @ 600 hp.	140
Government Aircraft Factories	.....	Canberra 20	Bomber	2	0	64'	65' 6"	15' 0"	960	.....	51,000	2 R-R Avon Mk. 109	...
Fisherman's Bend, Melbourne, Victoria	.....	Jindivik Mk. 2	Drone	0	0	19'	23' 4"	.....	76	1,730	2,800	1 A-S Viper ASV3	575
BELGIUM													
Avions Fairey S. A.	.....	Tipsy Junior Mk. VI	Persona	1	0	23'	18' 9½"	4' 0"	113	470	770	1 Con. @ 65 hp.	107
Gosselies	.....	Tipsy Primer	Trainer	2	0	32' 8"	27' 6"	6' 12"	155	1,548	2,138	1 DH Gipsy Major X @ 147 hp.	133
	.....	Tipsy Belfair	Personal	1	1	31' 2"	21' 8"	8' 7"	129.7	665	1,100	1 Walter Mikron @ 62 hp.	110
CANADA													
Avro Aircraft, Ltd.	CF-100 Mk. 5	.....	Interceptor	2	0	60' 10"	54' 2"	14' 6"	591	.....	33,600	2 Orenda 11 @ 7,000 lb. t.	
Box 4004, Terminal "A" Toronto, Ontario	CF-105	Arrow	AW Fighter	2	0	50'	77' 9"	21' 3"	.....	.....	70,000[1]	2 Orenda Iroquois @ 20,000 lb. t.	M=2
Canadair, Ltd.	.....	Sabre 6	Fighter	1	0	37' 11½"	37' 6"	14' 9"	.....	.....	.....	1 Orenda 14 @ 7,200 lb. t.	700
P. O. Box 6087, Montreal, Quebec	CP-107	Argus	Reconnaissance	15	0	142' 3½"	128' 3"	36' 8½"	2,075	.....	145,000	4 Wright R-3350 @ 3,700 hp.	290
	T-33A	Silver Star	Trainer	2	0	42' 5"	37' 8"	11' 6"	.....	.....	.....	1 R-R Nene 10 @ 5,100 lb. t.	
	CC-106	.....	Pass./Cargo	5-8	134	142' 3"	137'	36' 5"	2,075	91,184	205,000	4 Br. Orion 2 @ 5,150 eshp.	434
	CL-41	Canadair Trainer	Trainer	2	0	36' 4"	31' 11"	9'	230	4,100	6,500	1 Fair. J83 @ 2,000 lb. t.	463
The de Havilland Aircraft of Canada, Ltd.	DHC-2	Beaver	Transport	1-2	5-6	48'	30' 4"	10' 7"	230	2,951	5,100	1 P&W R985 @ 450 hp.	...
	DHC-3	Otter	Transport	1-2	9-10	58'	42'	15'	375	4,368	8,000	1 P&W R1340 @ 600 hp.	...
Station "L", Toronto, Ont.	DHC-4	Caribou	Transport	2	27-28	95'	66'	30'	920	14,500	24,000	2 P&W R2000 D5 @ 1,450 hp.	...
FRANCE													
Societe Boisavia,	B-603	Mercury	Personal	1	3	37' 6"	23' 0"	7' 6"	194	1,430	2,575	1 SNECMA 4LO2 @ 170 hp.	155
11, Rue Pierre Brossolette, Ivry-sur-Seine	B-260	Anjou	Personal	1	4	42' 8"	23' 7"	9' 10"	231	2,866	4,410	2 SNECMA 4LO2 @ 170 hp.	186
S. A. des Ateliers d'Aviation Louis Breguet	1001	Taon	Fighter	1	0	.....	37' 1"	12' 1½"	158	.....	11,025	1 Br. Orpheus 3 @ 4,850 lb. t.	...
	1100	.....	Fighter	1	0	23' 7"	41'	14' 3"	215	.....	13,230	2 Turb. Gabizo	M>1
24, Rue Georges Bizet, Paris (XVIe)	1050	Alize	Anti-Sub.	3	0	80' 2"	45'	17'	387.5	.....	17,640	1 R-R Dart R.Da.7 @ 2,000 eshp.	205
	940	.....	Pass./Cargo	...	21	57' 5"	39' 4"	.....	.....	.....	14,330	4 Turb. Turmo @ 400 hp.	236
	763	Deux Ponts	Transport	3	107	140' 8"	94' 11"	31' 4"	1,965	68,150	113,500	4 P&W CA-18 @ 2,400 hp.	272
Generale Aeronautique Marcel Dassault	.....	Mediterrance	Transport	...	7	.....	.....	.....	.....	.....	.....	2 A-S Viper @ 3,000 lb. t.	700*
78, Quai Carnot, Saint Cloud, (Seine-et-Oise)	M. IV A	Mystere IV A	Fighter-Bomber	1	0	36' 8"	42' 4"	14' 6"	344	12,492	17,000	1 H.S. Verdon @ 7,700 lb. t.	M<1
	M. IV B	Mystere IV B	Fighter-Bomber	1	0	36' 5½"	43' 11½"	14' 5"	344	.....	.....	1 R-R Avon Ra. 7R	...
	SM.B. 2	Super Mystere	Fighter-Bomber	1	0	34' 4"	46'	14' 11"	375	15,300	20,000	1 SNECMA Atar 101 G-2 @ 10,000 lb. t.	M=1
	Etendard IV-M	Etendard IV-M	Fighter	1	0	31'	.....	.....	305	.....	17,500	1 SNECMA Atar 8 @ 10,000 lb. t.	M=1
	Etendard IV	Etendard IV	Fighter-Bomber	1	0	27'	.....	.....	275	.....	16,000	1 Br. Orpheus 12 @ 8,000 lb.t.	M=1
	Mirage III-A	Mirage III-A	Interceptor	1	0	.....	.....	.....	.....	.....	17,000	1 SNECMA Atar 9 @ 13,500 lb. t. + 1 SEPR rocket	M>2
Air-Fouga	C.M. 170R	Magister	Trainer	2	0	37' 2"	33'	9' 2"	186	4,740	6,614	2 Turb. Marbore 2 @ 880 lb.t.	455
90, Rue Miromesnil, Paris (8e)													
Hurel-Dubois	H.D. 321	.....	Transport	3	44	148' 7½"	77' 4"	28' 7½"	1,076	24,498	41,200	2 Wright 982C9HE1 @ 1,525 hp.	206
Route de Verrieres Meudon-Villacoublay, (Seine-et-Oise)	H.D. 34	.....	Photo	7	0	148' 7½"	77' 6"	28' 7½"	1,076	26,300	42,600	2 Wright 982 C9 HE2 @ 1,475 hp.	206
Rene LeDuc et Fils	0.22	.....	Interceptor	1	0	.....	.....	.....	.....	.....	13,200	1 LeDuc ramjet + 1 SNECMA Atar D.3	M=2
158, Quai de Bezons Argenteuil (Seine-et-Oise)													
Societe de Avions Max Holste	Super Broussard	.....	Transport	1	17-20	70' 1"	51' 10"	.....	581	8,850	14,603	2 P&W R-1340 Wasp or 2 Turb. Bastan	225
17, Rue de Chateaubriand, Paris (8e)													

AI. — Alvis
A-S — Armstrong Siddeley
AW — All-Weather
Bl. — Blackburn & General
Br. — Bristol
Con. — Continental
DH — de Havilland
ENMASA — Empresa Nacional de Motores de Aviacion S.A.
Fair. — Fairchild
GE — General Electric
H.S. — Hispano-Suiza
Lyc. — Lycoming
P&W — Pratt & Whitney
R-R — Rolls-Royce
SEPR — Societe d'Etude de la Propulsion par Reaction
SNECMA — Societe National d'Etude et de Construction de Moteurs d'Aviation
Sven. — Svenska Flygmotor
Turb. — Turbomeca
* Cruise Speed
[1] Approximately
[2] AW. 660 is military version of AW. 650.

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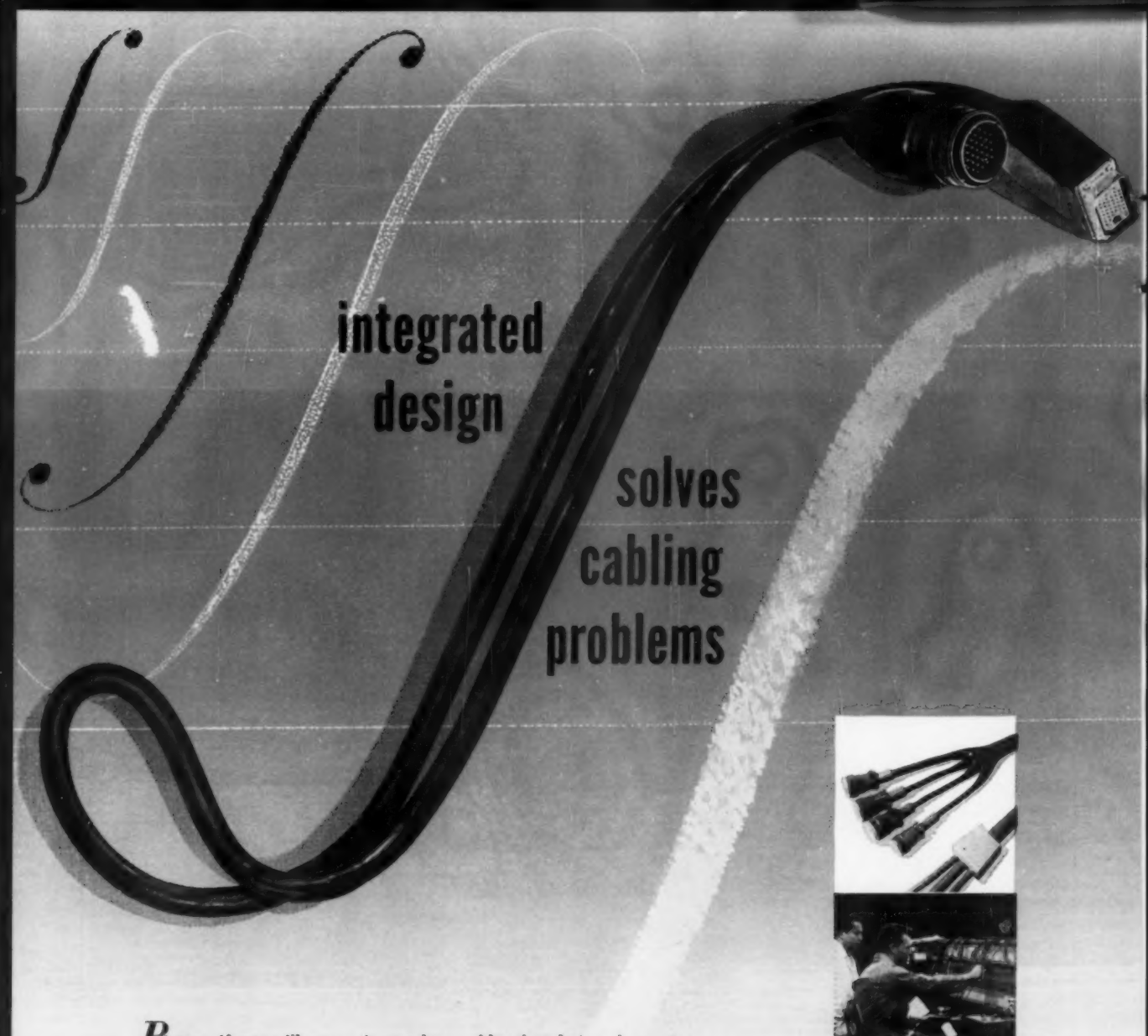
Aerodanes Morane-Saulnier *3-5 Rue Volta, Puteaux, (Seine)*	M.S. 733	Alcyon	Trainer	3	0	37′	31′ 1″	11′ 4″	235	2,810	3,850	1 Potez 6 DO2A @ 240 hp.	164
	M.S. 760	Paris	Business	1	3	33′ 3″	32′ 11″	8′ 7″	194	4,400	7,600	2 Turb. Marbore 2 @ 800 lb. t.	405
	M.S. 1500	Epervier	Attack	2	0	42′	34′ 8″	10′ 9″	259	3,530	6,060	1 Turb. Bastan @ 650 eshp.	199
Societe Nationale de Constructions Aeronautiques du Nord *12bis Avenue Bosquet, Paris (7e)*	Nord 2501	Noratlas	Transport	3	42	107′	72′	10′ 1″	1,083	28,600	48,400	2 SNECMA Hercules @ 2,040 hp.	275
	Nord 3202	.....	Trainer	2	0	32′ 1½″	26′ 2½″	10′ 3″	177.5	1,813	2,495	1 Potez 4D-32 @ 240 hp.	161
	Nord 1405	Gerfaut II	Fighter	1	0	24′ 7″	32′ 6″	13′ 6″	282	8,058	10,252	1 SNECMA Atar 101 G	...
	Nord 1500	Griffon II	Interceptor	1	0	26′	46′	16′ 5″	.....	.....	13,225	1 SNECMA Atar 101 F + 1 Nord ramjet	930
Piel Aviation *284, Avenue Jean-Jaures, Drancy, Seine*	C.P. 301	Emeraude	Personal	1	1	26′ 3½″	20′ 11½″	5′ 10″	116.7	758	1,345	1 Con. @ 90 hp.	130
Etablissements Henry Potez *40, Avenue Kleber, Paris (XVIe)*	Potez 75	.....	Attack	2	0	43′	30′	8′ 10″	.....	3,891	5,578	1 Potez 8D32 @ 520 hp.	171
Societe Industrielle Pour l'Aeronautique *178, Avenue de Neuilly, Neuilly (Seine)*	S. 1000	Coccinelle	Personal	1	1	29′ 6½″	17′ 10½″	7′ 2½″	137.8	737	1,367	1 Con. C 90-12F @ 90 hp.	124
SNECMA *150 Boulevard Haussman, Paris (XIIIe)*	C. 400 P-1	Atar Volant	VTOL	0	0	.....	.....	.....	.....	.....	.....	1 SNECMA Atar 101 DV @ 6,393 lb. t.	...
	C. 400 P-2	Atar Volant	VTOL	1	0	.....	.....	.....	.....	.....	5,730	1 SNECMA Atar 101 DV @ 6,393 lb. t.	...
	C. 400 P-3	Atar Volant	VTOL	1	0	.....	.....	.....	.....	.....	5,730	1 SNECMA Atar 101E @ 7,700 lb. t.	...
Sud Aviation *37, Boulevard de Montmorency, Paris (XVIe)*	S.E. 210	Caravelle	Transport	4	80	112′ 6″	104′ 10″	28′ 6″	1,579	57,000	94,800	2 R-R Avon Ra. 29 @ 10,500 lb. t.	465
	S.E. 5000	Baroudeur	Fighter	1	0	32′ 9″	44′ 3″	11′ 8″	272	10,260	14,710	1 SNECMA Atar 101 E-4 @ 8,200 lb. t.	650
	S.O. 4050	Vautour	Attack	2	0	50′	50′	15′	485	22,000	33,000	2 SNECMA Atar 101 E-3 @ 7,700 lb. t.	680
	S.O. 9050	Trident	Fighter	1	0	25′	42′	.....	177	.....	11,355	2 SEPR 631 rockets @ 6,615 lb. t.	...
	S.E. 212	Durandal	Fighter	1	0	21′ 4″	36′ 1″	13′ 1½″	236	6,000	8,930	1 SNECMA Atar G-3 @ 9,920 lb. t. + 1 SEPR 65 rocket @ 1,819 lb. t.	1,055
GERMANY													
Ingenieur-Buro Blume *Tausendfensterhaus, Duisberg-Ruhrort*	Blume Bl 502	.....	Personal	1	3	34′ 4″	26′ 8″	7′ 10″	161	1,370	2,340	1 Lyc. 0-320 @ 150 hp.	153
Dornier-Werke GmbH. *Friedrichshafen a.B.*	Do 27 A	.....	Multi	1	4	39′ 4½″	31′ 6″	8′ 10″	208.8	2,167	3,750	1 Lyc. GO 480-B1A6 @ 274 hp.	155
Rhein-West-Flug u. Companie *Amselstrasse 5, Porz-Westhoven*	RW.3-A2	Multoplane	Personal	1	1	49′ 3″	24′ 4″	6′ 10½″	193.7	982	1,434	1 Porsche @ 50 hp. or 1 Porsche Super @ 65hp.or 1 Porsche Spyder @ 100 hp.	... 130 150
	RW.3-A3	Multoplane	Personal	1	1	32′ 10″	24′ 4″	6′ 10½″	150.7	949	1,434	1Porsche @ 50 hp. or 1 Porsche Super @ 65 hp. or 1 Porsche Spyder @ 100 hp.	... 132 153
GREAT BRITAIN													
Sir W. G. Armstrong-Whitworth Aircraft Ltd. *Baginton, Coventry*	.....	Sea Hawk F.G.A.6	Fighter	1	0	39′	39′ 7″	8′ 8″	278	.....	.....	1 R-R Nene 103	...
	AW. 650P	Freightercoach	Pass./Cargo	2–3	77	115′	86′ 9″	27′	1,458	46,000	82,000	4 R-R Dart 526 R Da 7/2 @ 2,100 eshp.	276
	AW. 670	Air Ferry	Pass./Cargo	2	126	115′	86′ 9″	27′	1,458	48,650	82,000	4 R-R Dart 526 R DA 7/2 @ 2,100 eshp.	264
Auster Aircraft, Ltd. *Rearsby, Leicester*	J5B	Autocar	Personal	1	3	36′	23′ 2″	6′ 6″	185	.....	2,400	1 DH Gipsy Major 1@ 130 hp.	117
	J5F	Aiglet	Trainer	1	3	32′	23′ 2″	6′ 6″	164	1,380	2,200	1 DH Gipsy Major 1@ 130 hp.	125
	A.O.P.Mk.6	.....	Liaison	2	0	36′	23′ 8″	8′ 7″	185	1,417	2,105	1 DH Gipsy Major 7@ 145 hp.	123
	A.O.P.Mk.9	.....	Liaison	3	0	36′ 5″	23′ 8″	8′ 11″	198	1,558	2,100	1 B1 Bombardier @ 180 hp.	127
	B8	Agricola	Agricultural	1	2	42′	27′ 6″	8′ 3″	254.7	.....	3,670	1 Con. 0-470-M @ 240 hp.	127
Blackburn and General Aircraft, Ltd. *Brough, East Yorks*	G.A.L.60	Beverley	Transport	4	162	162′	99′ 6″	37′ 6″	2,916	84,740	143,000	4 Br. Centaurus @ 3,150 hp.	243
	N.A.39	.....	Strike	...	.....	.....	.....	.....	.....	.....	.....	2 DH Gyron Junior @ 7,000 lb. t.	...
The Bristol Aeroplane Co., Ltd. *Filton, Bristol*	175	Britannia 100	Transport	9	92	142′ 4″	114′	36′ 8″	2,075	86,000	155,000	4 Br. Proteus 705@ 3,900eshp.	370
	175	Britannia 300	Transport	9	132	142′ 4″	124′ 3″	36′ 8″	2,075	91,250	160,000	4 Br. Proteus 755@ 4,120eshp.	400
	175	Britannia 310	Transport	9	132	142′ 4″	124′ 3″	36′ 8″	2,075	87,785	180,000	4 Br. Proteus 755@ 4,120eshp.	400
	175	Britannia 250	Pass./Cargo	9	84	142′ 4″	124′ 3″	36′ 8″	2,075	89,405	180,000	4 Br. Proteus 755@ 4,120eshp.	400
	200	.....	Transport	...	79–99	91′	121′ 6″	28′ 3″	.....	.....	120,000	3 Br. Olympus or 3 R-R Conway	600+
The de Havilland Aircraft Co. Ltd. *Hatfield Aerodrome, Herts*	D.H. 110	Sea Vixen	AW Fighter	2	0	50′	53′ 6″	11′	.....	.....	.....	2 R-R Avon	M>1
	D.H. 104	Dove	Transport	2	8–11	57′	39′ 4″	13′ 4″	335	5,678	8,800	2 DH Gipsy Queen 70 Mk.2 @ 380 hp.	200
	D.H. 114	Heron	Transport	2	14–17	71′ 6″	48′ 6″	15′ 7″	499	8,484	13,500	4 DH Gipsy Queen 30 Mk.2 @ 250 hp.	191
	D.H. 106	Comet 4	Transport	5	60–76	115′	111′ 6″	28′ 6″	2,121	70,400	152,500	4 R-R Avon @ 10,500 lb. t.	500*
	D.H. 106	Comet 4B	Transport	4	99	107′ 9″	118′	28′ 6″	2,059	102,500	152,500	4 R-R Avon 29 @ 10,500 lb. t.	M = .78
	D.H. 106	Comet 4C	Transport	4	99	115′	118′	28′ 6″	2,121	102,500	156,000	4 R-R Avon 29 @ 10,500 lb. t.	M = .75
	D.H. 121	.....	Transport	...	.....	.....	.....	.....	.....	.....	.....	3 R-R RB-41 @ 12,000 lb. t.	...



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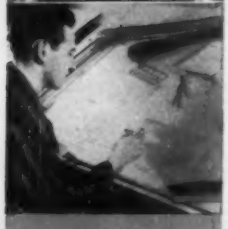

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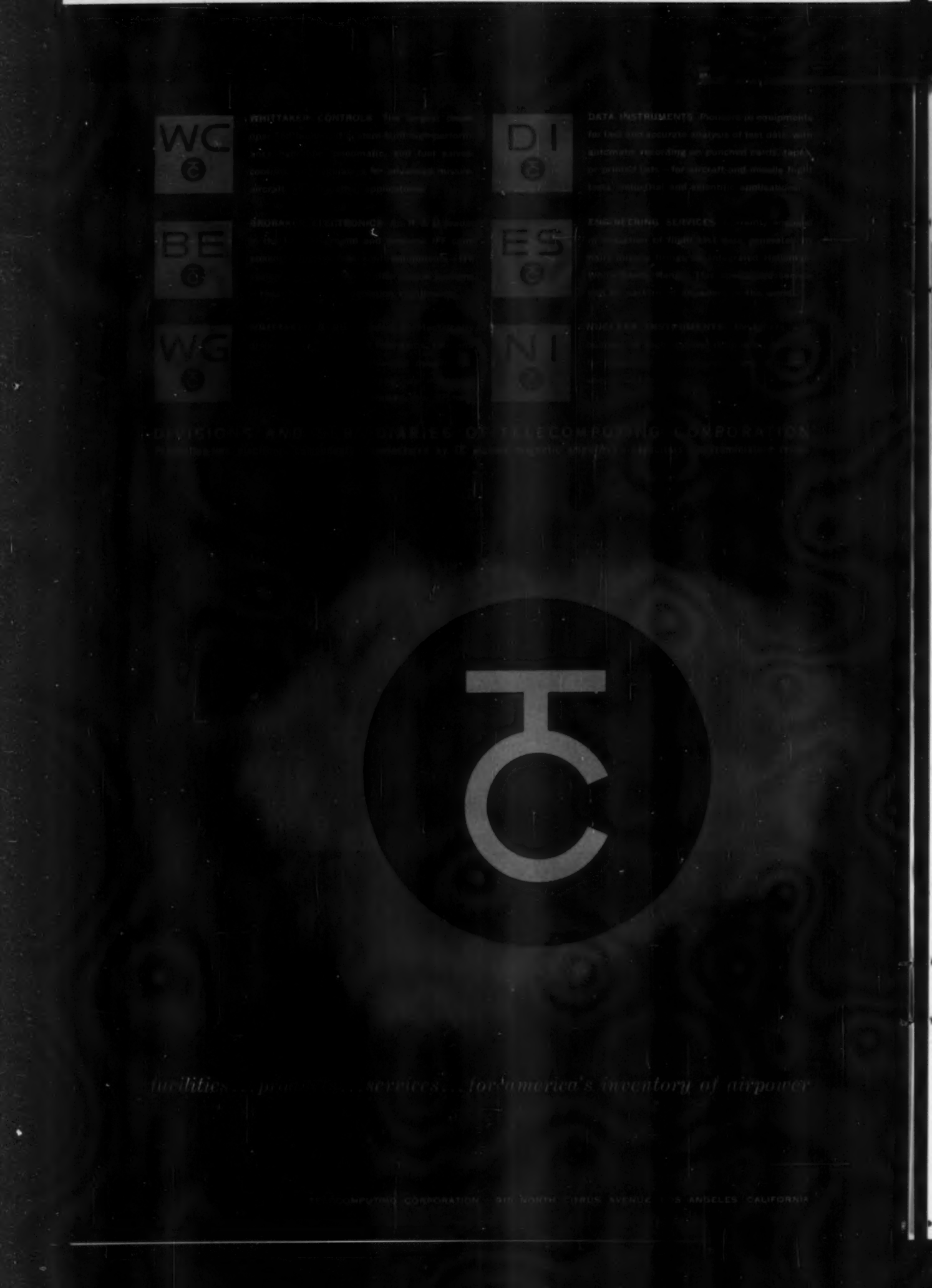
The English Electric Co., Ltd.	P. 1	.....	Fighter	1	0	.....	.....	.....	.....	.....	.....	2 R-R Avon + 1 Napier Double-Scorpion rocket	M>2
Queen's House, Kingsway, London W.C.2	.....	Canberra T. 4	Trainer	3	0	64′	65′ 6″	15′ 7″	960	.....	.....	2 R-R Avon	...
	.....	Canberra P.R. 7	Photo Reconn.	2	0	64′	66′ 9″	15′ 7″	960	.....	.....	2 R-R Avon	...
	.....	Canberra P.R. 9	Photo Reconn.	2	0	68′	66′ 9″	15′ 7″	960	.....	.....	2 R-R Avon	...
	.....	Canberra B. 8	Bomber	2	0	64′	65′ 6″	15′ 7″	960	.....	.....	2 R-R Avon	...
The Fairey Aviation Co., Ltd.	.....	Gannet Mk. 2	Trainer	4	0	54′ 3″	43′	13′ 8″	.....	.....	.....	1 A-S Double Mamba 100 @ 2,950 eshp.	...
Hayes, Middlesex	.....	Gannet Mk. 3	Early Warning	3	0	54′ 7″	44′	16′ 9″	.....	.....	.....	1 A-S Double Mamba	...
	.....	Gannet A.S. Mk. 4	Anti-Sub.	3	0	54′ 3″	43′	13′	.....	.....	.....	1 A-S Double Mamba	...
	.....	Delta 2	Research	1	0	26′ 9″	51′ 8″	11′	.....	.....	.....	1 R-R Avon	M>1
Folland Aircraft, Ltd.	Fo. 141	Gnat Mk. 1	Fighter	1	0	22′ 1″	29′ 8″	7′ 7″	137	3,917	6,191	1 Br. Orpheus 701@4,850lb.t.	M = .98
Hamble, Southampton, Hampshire													
Gloster Aircraft Co., Ltd.	.....	Javelin T. 3	Trainer	2	0	52′	60′ 2″	16′	930	.....	.....	2 A-S Sapphire @ 8,300 lb. t.	...
Gloucester	.....	Javelin F (AW) 7	AW Fighter	2	0	52′	56′ 4″	16′	930	.....	.....	2 A-S Sapphire @ 11,000 lb. t.	...
Handley Page, Ltd.	H.P. 80	Victor B.Mk. 1	Bomber	...	.....	110′	114′ 11″	28′ 1½″	.....	.....	.....	4 A-S Sapphire	...
Cricklewood, London, N.W.2	.....	Victor B.Mk. 2	Bomber									4 R-R Conway	...
	H.P.R. 3	Leonides Herald	Transport	2	44	94′ 9½″	70′ 3″	22′ 4″	886	23,200	37,500	4 Al. Leonides Major @ 866 hp.	248
	H.P.R. 3	Dart Herald	Transport	2	44	94′ 9½″	71′ 11″	22′ 4″	886	21,422	37,000	2 R-R Dart R.Da.7 Mk.527 @ 1,910 eshp.	295
Hawker Aircraft, Ltd.	P. 1121	.....	Strike	1	0	.....	.....	.....	.....	.....	.....	1 DH Gyron	M>1
Canbury Park Road, Kingston-on-Thames, Surrey	P. 1067	Hunter F.4	Fighter	1	0	33′ 8″	45′ 10½″	13′ 2″	340	.....	.....	1 R-R Avon RA21@8,000lb.t.	...
	P. 1067	Hunter F. 6	Fighter	1	0	33′ 8″	45′ 10½″	13′ 2″	340	.....	.....	1 R-R Avon RA28@10,000 lb. t.	...
	P. 1101	Hunter T. 7	Trainer	2	0	33′ 8″	48′ 10½″	13′ 2″	340	.....	.....	1 R-R Avon RA21 or RA28	...
Hunting Aircraft, Ltd.	.....	President	Transport	2	12	64′ 6″	46′	16′	400	.....	13,500	2 Al. Leonides @ 550 hp.	223
Luton Airport, Luton, Bedfordshire	.....	Pembroke	Multi	2	12	64′ 6″	46′	16′	400	.....	13,500	2 Al. Leonides @ 550 hp.	223
	.....	Provost T.Mk. 1	Trainer	2	0	35′ 2″	28′ 9″	12′ 2″	214	.....	4,400	1 Al. Leonides @ 550 hp.	201
	.....	Jet Provost T.Mk. 3	Trainer	2	0	35′ 10″	32′ 4″	10′ 2″	214	.....	6,195	1 A-S Viper @ 1,750 lb. t.	329
M. L. Aviation Co., Ltd.	.....	Utility Mk. 1	Personal	1	1	35′	23′ 3″	10′ 6″	400	515	1,000	1 Walter Mikron III@38.5hp.	58
White Waltham, Maidenhead, Berkshire													
F. G. Miles, Ltd.	M.100	Student	Trainer	2	0	29′ 2″	31′ 6″	6′ 3″	144	2,365	3,600	1 Turb. Marbore @ 883 lb. t.	295
Shoreham Airport, Sussex	M.100	Centurion	Trainer	2	0	29′ 2″	31′ 6″	6′ 3″	144	2,480	4,000	1 R-R RB 108 derated to 1,400 lb. t.	351
	HDM 105	.....	Research	1	9	75′ 4″	34′ 4″	13′ 11″	279	.....	6,060	2 Bl. Cirrus Major III @ 155 hp.	136
	HDM 106	Caravan	Transport	1	15	75′ 4″	37′ 10″	11′ 5″	279	4,220	8,000	2 Lyc. GSO-480B @ 340 hp.	168
Edgar Percival Aircraft Ltd.	EP. 9	.....	Multi	1–2	2–4	43′ 6″	30′	10′	227.6	2,010	3,700	1 Lyc. GO-480B @ 275 hp.	146
Stapleford Aerodrome, Romford, Essex													
A. V. Roe, & Co., Ltd.	698	Avro Vulcan B.Mk. 1	Bomber	5	0	99′	97′ 1″	26′ 6″	.....	.....	.....	4 Br. Olympus	...
Greengate, Middlesex, Manchester	698	Avro Vulcan B.Mk. 2	Bomber	5	0	111′	97′ 1″	27′ 6″	.....	.....	.....	4 Br. Olympus BOL. 6	...
	696	Avro Shackleton MR.3	Anti-Sub.	10	0	120′ 7″	87′ 4″	23′ 4″	.....	.....	.....	4 R-R Griffin	...
Saunders-Roe, Ltd.	SR. 53	.....	Interceptor	1	0	25′ 1¼″	45′	10′ 10″	.....	.....	.....	1 A-S Viper @ 1,750 lb. t. + 1 DH Spectre rocket	M>2
Osborne, East Cowes, Isle of Wight	SR. 177	.....	Interceptor	1	0	.....	.....	.....	.....	.....	.....	1 DH Gyron Jr. @ 8–10,000 lb. t. + 1 DH Spectre rocket @ 8,000 lb. t.	M>2
Scottish Aviation, Ltd.	.....	Pioneer CC Mk. 1	Transport	1	5	49′ 9″	34′ 4″	10′ 4″	390	3,993	5,800	1 Al. Leonides 502/7@540hp.	160
Prestwick Airport, Ayrshire	.....	Twin Pioneer	Multi	2	16	76′ 6″	45′ 3″	12′ 3″	670	9,102	15,000	2 Al. Leonides 514/8@540hp.	167
Short Brothers & Harland, Ltd.	S.B. 5	.....	Research	1	0	30′ 6″	45′ 9″	.....	.....	.....	.....	1 R-R Derwent	...
P.O.Box 241, Queen's Island, Belfast	SC. 1	.....	VTOL	1	0	23′ 6″	24′ 4″	10′ 7″	.....	.....	.....	5 R-R RB108	...
Vickers-Armstrongs (Aircraft), Ltd.	700D	Viscount	Transport	2	40–53	93′ 8″	81′ 9″	27′ 9″	963	37,200	57,000	4 R-R Dart 6 @ 1,740 eshp.	330
Weybridge, Surrey	796	Viscount	Transport	3	53–63	93′ 8½″	81′ 9″	27′ 9″	963	.....	61,500	4 R-R Dart RDa. 2 506	...
	800	Viscount	Transport	3	44–70	93′ 8″	85′ 8″	26′ 9″	963	39,900	60,750	4 R-R Dart 6 @ 1,740 eshp.	335
	810	Viscount	Transport	2	44–65	93′ 8″	85′ 8″	26′ 9″	963	40,540	63,750	4 R-R Dart 7 @ 1,990 eshp.	425
	840	Viscount	Transport	2	44–65	93′ 8″	85′ 8″	26′ 9″	963	41,130	64,500	4 R-R Dart 11 @ 2,080 eshp.	425
	950	Vanguard	Transport	3	76–130	118′	122′ 10½″	35′	1,527	72,000	127,500	4 R-R Tyne @ 5,375 eshp.	450
	VC. 10	.....	Transport	...	147	140′	158′	.....	2,800	.....	299,000	4 R-R bypass @ 17,500 lb. t.	...
	.....	Scimitar Mk. 1	Fighter	1	0	37′ 2″	55′ 4″	15′	.....	.....	.....	2 R-R Avon 200 series	...
	674	Valiant	Bomber	5	0	114′ 4″	108′ 3″	34′ 2″	.....	.....	.....	4 R-R Avon	...
	.....	Swift F.R.Mk. 5	Fighter	1	0	32′ 4″	41′ 5½″	13′ 6″	306	.....	.....	1 R-R Avon	...
ITALY													
Industrie Meccaniche Aeronautiche Meridionali-AERFER	.....	A.S. Sagittario II	Fighter	1	0	24′ 7″	31′ 2″	6′ 7″	158	4,960	7,160	1 R-R Derwent 9 @ 3,600 lb. t.	620
30, Corso Malta, Naples													
Construzioni Aeronautiche Giovanni Agusta	AZ-8L	.....	Transport	2	22	83′ 8″	63′ 9″	21′ 8″	719	.....	23,810	4 Al. Leonides Mk.22 (503/2) @ 470 hp.	252
Cascina Costa, Gallarate	AZ-8S	.....	Transport	2	22	83′ 8″	63′ 9″	21′ 8″	719	.....	23,810	4 SNECMA 12S @ 575 hp.	...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Leading Foreign Aircraft, Military and Civil

Manufacturer	Model designation	Aircraft name	Primary mission	Max. No. of crew	Max. No. of passengers	Overall wingspan, ft.	Overall length, ft.	Maximum height, ft.	Wing gross area, sq. ft.	Weight empty, lb.	Gross weight, lb.	Number, make, model and max. rating of powerplants	Max. speed, mph.
Societa Aeronautica Italiana, Ing. A. Ambrosini & Co. *Viale Masno 23, Milan*	P. 18	.....	Trainer	2	0	32′ 6″	24′ 7″	9′ 6″	150.7	1,543	2,866	1 Turb. Marbore II@880lb.t.	337
	F. 7	Rondone	Personal	1	1	30′ 6″	22′ 4″	9′ 2″	114	1,056	1,694	1 Con. C90 @ 90 hp. or 1 Lyc. O-290-D2 @ 135 hp.	150 165
Fiat-Divisione Aviazione *Corso G. Agnelli, 200, Turin*	G. 82	.....	Trainer	2	0	38′ 8″	42′ 5″	13′ 3″	271	9,700	13,780	1 R-R Nene RN6121 @ 5,900 lb. t.	575
	G. 91	.....	Fighter	1	0	.....	.....	.....	.....	.....	.....	1 Br. Orpheus B.Or. 3 @ 4,850 lb. t.	M>1
	G. 91T	.....	Trainer	2	0	.....	.....	.....	.....	.....	11,025	1 Br. Orpheus B.Or. 4	...
	G. 91R	.....	Photo Reconn.	1	0	.....	.....	.....	.....	.....	.....	1 Br. Orpheus 3	...
	F. 86K	.....	Fighter	1	0	37′ 2″	40′ 10″	15′	288	.....	18,000	1 GE J47-GE-17B@7,350lb.t.	650
	Vamp. Mk. 52	.....	Fighter	1	0	38′	30′ 9″	6′ 2″	270	6,835	10,650	1 DH Goblin 3 @ 3,300 lb. t.	480
Aeronautica Macchi *Corso Vittorio Emanuele 31, Milan*	MB. 326	.....	Trainer	2	0	32′ 11″	34′ 6″	5′ 3″	204.5	4,299	6,283	1 A-S Viper ASV8@1,750lb.t.	450
Nardi S.A. per Construzioni Aeronautiche *Aeroporto Forlanini, Milan*	FN-333	.....	Personal	1	3	32′ 9″	24′	10′ 6″	161.5	1,896	2,976	1 Con. O-470-H @ 240 hp.	180
Partenavia Construzioni Aeronautiche *Via Tasso, 480, Naples*	P.48B	Astore	Personal	2	0	26′ 8″	17′ 11″	5′ 9″	92.2	617	1,036	1 Con. A 65 @ 65 hp.	115
	P.52	Tigrotto	Personal	1	1	29′ 6″	19′ 3″	5′ 7″	117.3	948	1,587	1 Con. C 90 @ 95 hp.	147
	P.53	Aeroscooter	Personal	1	0	27′ 2″	16′ 9″	5′ 6″	89.3	397	617	1 Giannini 40 @ 40 hp.	93
	P.55	Tornado	Personal	1	1	23′ 7″	19′ 9″	5′ 11″	86	1,058	1,566	1 Lyc. O 320 A @ 150 hp.	215
	P.57	Fachiro	Personal	1	3	30′ 2″	20′ 2″	5′ 4″	145.3	1,078	1,991	1 Lyc. O 320 A @ 150 hp. or 1 Lyc. O 340 A @ 170 hp.	144
Piaggio & C. Societa per Azioni *Via Antonio Cecchi 6, Genoa*	P. 136-L1	.....	Personal	1	4	44′ 4″	35′ 6″	12′ 7″	270	4,400	6,000	2 Lyc. GO-480-B1A6@270hp.	183
	P. 136-L2	.....	Personal	1	4	44′ 4″	35′ 6″	12′ 7″	270	4,652	6,600	2 Lyc. GSO-480-A1A6 @ 340 hp.	208
	P. 149-D	.....	Personal	1	4	36′ 6″	28′ 11″	9′ 6″	203	2,557	3,704	1 Lyc. GO-480-B1A6@270hp.	192
	P. 166	.....	Personal	1	7	46′ 8″	38′	16′ 4″	286	4,620	7,700	2 Lyc. GSO-480-A1A6 @ 340 hp.	225
	P. 155-SAM-1	.....	Amphibian	7	5–10	.....	.....	.....	.....	.....	.....	2 P&W R-2800	220
JAPAN													
Fuji Heavy Industries Ltd. *No. 18, 2-chome, Marunouchi, Chiyoda-ku, Tokyo*	T1F1	.....	Trainer	2	0	34′ 6″	39′ 4″	.....	236.8	.....	7,275	1 Br. Orpheus	496
	LM-1	Nikko	Multi	1	3	32′ 11″	25′ 11″	9′ 6″	178	2,080	3,245	1 Con. O-470-13A @ 225 hp.	185
Kawasaki Aircraft Co., Ltd. *P.O. Box 644, Kobe Central*	KAT-1	KAT-1	Trainer	2	0	37′ 9″	27′ 11″	9′ 2″	200.2	2,360	3,053	1 Lyc. GO-435-C2B @ 260 hp.	188
	KAL-2	KAL-2	Multi	2	2–3	39′ 1½″	28′ 11¼″	8′ 10″	211	2,450	3,530	1 Lyc. GO-435-C2B@260hp.	182
NETHERLANDS													
Royal Dutch Aircraft Factories (Fokker) *Schiphol-Zvid*	Fokker F.27	Friendship	Transport	2	32–40	95′ 2″	75′ 9″	27′ 6″	754	22,000	35,700	2 R-R Dart RDa. 6 Mk.511 @ 1,600 eshp. or 2 R-R Dart RDa. 7 Mk.528 @ 1,800 eshp.	268* 300*
	Fokker F.27	Friendship "De-Luxe"	Transport	2	16	95′ 2″	75′ 9″	27′ 6″	754	23,600	.....	2 R-R Dart RDa. 6 Mk.511 @ 1,600 eshp. or 2 R-R Dart RDa. 7 Mk. 528 @ 1,800 eshp.	268* 300*
	Fokker F.27	Freightship	Pass./Cargo	...	.....	95′ 2″	75′ 9″	27′ 6″	754	.....	.....	.....	...
SPAIN													
Aeronautica Industrial, S.A. *Plaza de las Cortes 2, Madrid*	XL-10	AVD 12	Liaison	1	2	36′ 2″	25′ 4″	6′ 11″	194	1,590	2,430	1 ENMASA Tigre G-IV-B @ 150 hp.	140
	XL-10C	AVD 12C	Liaison	1	3	36′ 2″	25′ 4″	6′ 11″	194	1,668	2,868	1 Con. O-470-A @ 225 hp.	173
	L.8C	I-11B	Trainer	2	0	30′ 6″	20′ 1″	6′ 2″	144	928	1,430	1 Con. C-90 12F @ 95 hp.	124
	E-6	I-115	Trainer	2	0	31′ 3″	24′ 1″	9′	151	1,499	2,183	1 ENMASA Tigre G-IV-B @ 150 hp.	149
Construcciones Aeronauticas, S.A. *Rey Francisco, 4, Madrid*	CASA 202B	Halcon	Transport	2	6	67′ 6″	52′ 6″	20′ 11″	603	13,820	18,740	2 Wright Cyclone R-1820-56 @ 1,300 hp.	257
	T.7	Azor	Transport	4	30–40	91′ 2″	68′ 5″	25′ 5″	924	21,660	33,950	2 Br. Hercules 730@2,040hp.	285
	T.6	Halcon	Transport	3	14	70′ 9″	52′ 6″	19′ 11″	618	11,570	17,090	2 ENMASA Beta B IV @ 775 hp.	230
	T.5	Alcotan	Transport	3	10	60′ 5″	45′ 3″	13′	450	8,600	11,250	2 A-S Cheetah 27 @ 475 hp.	195
La Hispano Aviacion, S.A. *Avenida de Jose Antonio 7, Madrid*	HA-100-E1	Triana	Trainer	2	0	34′ 1″	27′ 9″	11′	187	4,343	6,459	1 ENMASA Beta @ 755 hp.	276
	HA-200-R1	Saeta	Trainer	2	0	34′ 2″	29′ 1″	10′ 8″	187	3,697	7,000	2 Turb. Marbore IIA @ 880 lb. t.	435
SWEDEN													
Svenska Aeroplan A.B. *Linkoping*	Saab-29	J-29	Fighter	1	0	36′ 1″	33′ 2″	12′ 4″	258	9,480	13,360	1 Sven. RM-2 @ 5,000 lb. t.	660
	Saab-J29F	J-29F	Fighter	1	0	36′ 1″	33′ 2″	12′ 3″	258	.....	.....	1 Sven. RM-2 @ 6,175 lb. t.	660
	Saab-32A	Lansen	AW Attack	2	0	42′ 8″	48′ 1″	15′ 8″	.....	15,500	22,000	1 Sven. RM-5 @ 9,500 lb. t.	700
	Saab-J32B	Lansen	AW Interceptor	2	0	42′ 8″	48′	15′ 6″	.....	.....	.....	1 Sven. RM-6	...
	Saab-32C	Lansen	Photo Reconn.	2	0	42′ 8″	48′ 1″	15′ 8″	.....	.....	.....	1 Sven. RM-6	...
	Saab-35	Draken	AW Fighter	1	0	30′ 10″	46′ 7″	.....	.....	.....	.....	1 Sven. RM-6	M>1
	Saab-90A-2	Scandia	Transport	3	40	91′ 11″	69′ 11″	23′ 3″	922	21,960	35,270	2 P&W R2180-E1@1,800hp.	277
	Saab-91B	Safir	Trainer	3	0	34′ 9″	26′	7′ 2″	146	1,580	2,315	1 Lyc. O435-A @ 190 hp.	170
	Saab-91C	Safir	Personal	1	3	34′ 9″	26′	7′ 2″	146	1,625	2,685	1 Lyc. O435-A @ 190 hp.	169
SWITZERLAND													
Flug & Fahrzeugwerke A.G. *Altenrhein bei Rorschach*	P-16	.....	Attack	1	0	37′ 1″	47′ 4″	14′ 2″	322.9	.....	20,000	1 A-S Sapphire 7 @ 11,000 lb. t.	...

Details of missile development are secret and can only be discussed on a "need to know" basis. But when it comes to missile component reliability, it's no secret that Exide has the most experienced engineering team and the best laboratory facilities in the industry.

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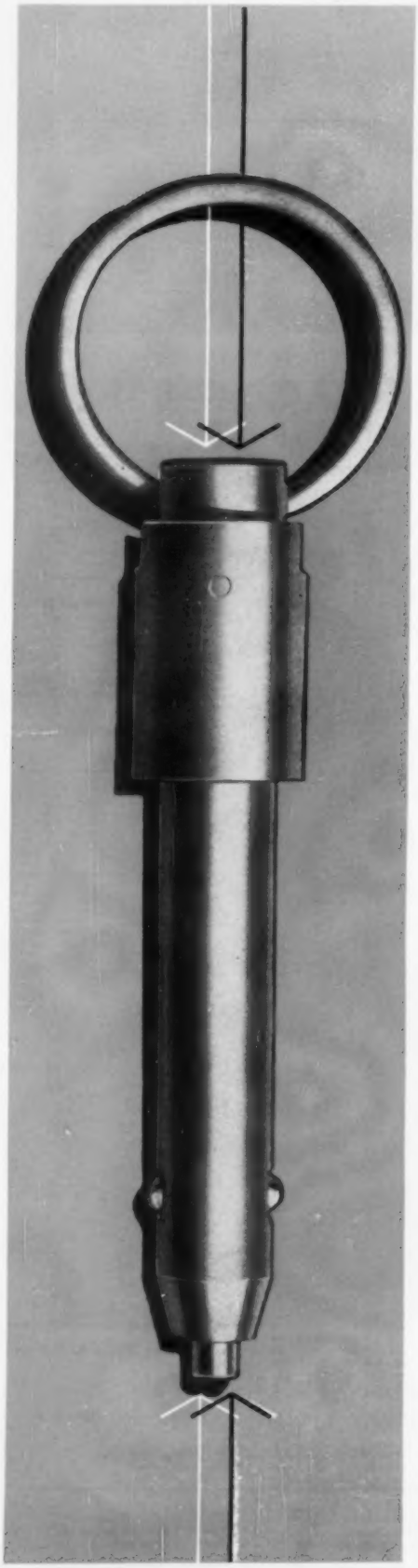
Leading Foreign Gas Turbines

Manufacturer	Basic Data					Performance			Physical Data			Remarks
	Military designation	Type	No. compressor stages	No. turbine stages	No. combustors	Max. power at S.L.	Specific fuel consumption at max. power	Compression ratio at max. rpm.	Maximum envelope diameter, in.	Maximum envelope length, in.	Dry weight, less tailpipe, lb.	
CANADA												
Orenda Engines, Ltd.	Orenda 10	AFJ	10	1	6	6,355 lb. t.	1.12	5.3	42	123	2,515	
Malton, Ont.	Orenda 11	AFJ	10	2	6	7,275 lb. t.	.99	6.1	45	121	2,425	
	Orenda 14	AFJ	10	2	6	7,275 lb. t.	.99	6.1	45	121	2,425	
	Iroquois PS-13	AFJ	.....	.....	A	23,000 lb. t.	.....	.....	.....	.....	4,500	30,000+ lb. t. w/afterburner
GREAT BRITAIN												
Armstrong-Siddeley Motors, Ltd	Mamba ASM. 8	AFP	11	3	A	1,950 eshp.	.65	5.84	34	61	950	
Parkside, Coventry	Double Mamba ASMD. 3	AFP	10	3	A	2,690 eshp.	.....	5.35	53	99	2,405	
	Double Mamba ASMD. 8	AFP	11/2	3/2	A/2	3,875 eshp.	0.71	.....	.....	.....	2,450	In production
	P. 182	ACFP	2A, 1C	2/1	A	1,100 eshp.	.....	.....	.....	.....	600	Also P. 181 version for he i-copters
	Viper ASV. 8	AFJ	7	1	A	1,750 lb. t.	1.11	4.0	24	66	530	
	Viper ASV. 9	AFJ	7	1	A	1,900 lb. t.	1.14	.....	24	66	525	Uprated ASV. 8
	Viper ASV. 10	AFJ	.....	.....	A	2,000 lb. t.	1.01	.....	28	66	570	
	Viper ASV. 11	AFJ	7	1	A	2,450 lb. t.	1.11	.....	24	68	570	Uprated ASV. 10
	Sapphire ASSa. 6	AFJ	13	2	A	8,300 lb. t.	0.85	7.5	37	110	2,670	
	Sapphire ASSa. 6R	AFJ	13	2	A	10,000 lb. t.	1.76	.....	37	110	2,608	Afterburner version
	Sapphire ASSa. 7	AFJ	13	2	A	11,000 lb. t.	0.88	7.3	37	108	3,075	Also ASSa. 5&8
Bristol Aero-Engines, Ltd.	Proteus 705	ACFP	12A, 1C	2/2	8	3,900 eshp.	0.62	7.2	40	100.6	2,945	Britannia 102
Filton, Bristol	Proteus 755	ACFP	12A, 1C	2/2	8	4,120 eshp.	0.60	7.2	40	100.6	2,900	Britannia 250, 300 and 310
	Olympus 101	AFJ	6A/8A	1/1	A	11,000 lb. t.	0.82	.....	41	128	3,600	In production
	Olympus 102	AFJ	7A/8A	1/1	A	12,000 lb. t.	0.81	.....	42	132	3,800	for
	Olympus 104	AFJ	.....	.....	A	13,000 lb. t.	.....	.....	42	132	.....	Vulcan bomber
	Olympus 200	AFJ	.....	.....	A	16,000 lb. t.	.....	.....	42	126.4	.....	
	Orpheus B. Or 2	AFJ	7	1	A	4,520 lb. t.	.....	.....	32	73.0	790	For Folland Gnat
	Orpheus B. Or 3	AFJ	7	1	A	4,850 lb. t.	1.05	.....	32	75.45	825	For G91, Etendard VI, Taon
	Orpheus B. Or 4	AFJ	7	1	A	4,230 lb. t.	0.96	.....	32	75.55	890	For Gnat Trainer, G91 Trainer
	Orpheus B. Or. 11	AFJ	.....	.....	A	5,760 lb. t.	.....	.....	32	79.27	.....	
	Orpheus B. Or. 12		.....	.....	A	8,000 lb. t.	.....	.....	32	82.7	.....	
	Orion B. On. 1	AFP	7A/5A	1/3	A	5,150 eshp.	0.64	10	42	112.3	3,200	sfc. = .395 at altitude
	Orion B. On. 2	AFP	7A/5A	1/3	A	5,150 eshp.	0.64	10	42	112.3	3,200	
	Thor	RJ	0	0	1	.....	.....	.....	16	94.5	.....	For Bloodhound
De Havilland Engine Co. Ltd.	Gobbin 35	CFJ	1	1	16	3,500 lb. t.	1.16	3.7	50	101	1,630	
Edgware, Middlesex	Ghost 103	CFJ	1	1	10	4,850 lb. t.	1.15	4.5	53	123	1,925	
	Ghost 105	CFJ	1	1	10	5,350 lb. t.	1.19	4.7	53	129	1,935	
	Gyron	AFJ	.....	.....	.....	25,000 lb. t.	.....	.....	50	155.5	4,200	
	Gyron Jr. DGJ.1	AFJ	.....	.....	.....	7,000 lb. t.	.....	.....	35	100	.....	
	Gyron DGy.2	AFJ	7	2	A	20,000 lb. t.	1.04	.....	46	155	4,270	
	Gyron Jr. DGJ.1	AFJ	.....	.....	.....	7,000 lb. t.	.....	.....	32	94	.....	
N. Napier & Son, Ltd.	Eland N.El.1	AFP	10	3	6	3,030 eshp.	0.64	7.0	36	122	1,575	
London, W. 3	Eland N.El.3	AFP/G	10/9	3	6	3,000 eshp.	0.62	7.0	36	158	2,350	
	Eland N.El.4	AFP	10	3	6	4,000 eshp.	0.55	7.0	36	122	1,800	
	Eland N.El.5	AFP	.....	3	6	4,200 eshp.	0.56	8.0	36	122	1,800	
	Eland N.El.6	AFP	10	3	6	3,500 eshp.	0.59	7.0	36	122	1,735	
	Oryx N.Or.1	AFG	12/4	2	5	780 ghp.	0.68	6.0	19	83	495	
	Oryx N.Or.4	AFG	12/4	2	5	865 ghp.	0.65	6.0	19	83	495	
	Oryx N.Or.5	AFG	12/4	2	5	950 ghp.	0.62	6.1	19	83	515	
	Gazelle N.Ga.1	AFP	11	2+1	6	1,260 shp.	0.71	6.37	34	70	780	
	Gazelle N.Ga.2	AFP	11	2+1	6	1,650 shp.	0.68	6.37	34	70	830	
	Gazelle N.Ga.3	AFP	11	2+1	6	1,800 shp.	0.66	6.37	34	70	865	
	Gazelle N.Ga.4	AFP	11	2+1	6	2,000 shp.	0.635	6.37	34	70	900	
Rolls-Royce, Ltd.	Avon RA.7	AFJ	12	2	8	7,500 lb. t.	0.92	6.5	42	112	2,460	
Derby	Avon RA.7R	AFJ	12	2	8	9,500 lb. t.	1.90	6.5	42	120	2,895	Afterburner version
	Avon RA.21	AFJ	12	2	8	8,000 lb. t.	0.93	6.5	42	117	2,478	
	Avon RA.14	AFJ	15	2	A	9,500 lb. t.	0.84	7.8	42	113	2,897	
	Avon RA.26	AFJ	15	2	A	10,000 lb. t.	0.86	.....	42	113	2,790	Civil version
	Avon RA.28	AFJ	15	2	A	10,000 lb. t.	0.86	.....	42	113	2,890	Modified RA.28 in Ryan X-13
	Avon RA.24	AFJ	15	2	A	11,250 lb. t.	.....	.....	.....	.....	.....	
	Avon RA.24R	AFJ	15	2	A	.....	.....	.....	.....	.....	.....	Afterburner version
	Avon RA.29	AFJ	16	3	A	10,500 lb. t.	0.775	.....	42	126	3,326	Civil version for D.H. Comet and S.A. Caravelle
	Conway R.Co.5&7	BPJ	.....	.....	A	13,000 lb. t.	.....	.....	42	129	.....	
	Conway R.Co. 10	BPJ	.....	.....	A	16,500 lb. t.	.....	.....	42	131	.....	Civil version for 707 & DC-8
	Conway R. Co. 11	BPJ	.....	.....	A	17,250 lb. t.	.....	.....	42	136	.....	H.P. Victor B. Mk. 2.
	Dart Mk. 506	CFP	2	2	7	1,540 eshp.	0.727	5.5	38	95	1,030	Vickers Viscount
	Dart Mk. 510	CFP	2	2	7	1,740 eshp.	0.689	5.5	38	98	1,110	700 & 800 Series
	Dart Mk. 511	CFP	2	2	7	1,720 eshp.	0.698	5.5	38	98	1,195	Fokker/Fairchild F-27
	Dart Mk. 520	CFP	2	3	7	1,890 eshp.	0.700	5.8	38	98	1,250	Viscount 803
	Dart Mk. 525	CFP	2	3	7	1,990 eshp.	0.68	5.8	38	98	1,250	Viscount 810
	Dart Mk. 526	CFP	2	3	7	2,100 eshp.	0.665	5.8	38	98	1,250	A.W. 650 Freightercoach
	Dart Mk. 527	CFP	2	3	7	2,100 eshp.	0.665	5.8	38	98	1,260	H.P. Dart Herald
	Dart Mk. 528	CFP	2	3	7	1,960 eshp.	0.690	5.8	38	98	1,273	F-27
	Dart Mk. 529	CFP	2	3	7	2,100 eshp.	0.665	5.8	38	98	1,269	Grumman Gulfstream
	Dart Mk. 21	CFP	2	3	7	2,150 eshp.	0.610	5.8	38	98	1,240	Military version for 1050 Alize
	Dart R.Da.10	CFP	2	3	7	2,660 eshp.	0.640	6.25	38	98	1,323	
	Dart Mk.541	CFP	2	3	7	2,350 eshp.	0.675	6.25	38	98	1,323	Derated RDa.10 for Viscount 840
	Nene Mk.10	CFJ	1	1	9	5,100 lb. t.	1.06	4.45	50	105	1,620	
	Nene Mk. 101	CFJ	1	1	9	5,000 lb. t.	1.09	4.45	50	78	1,618	
	Nene Mk. 3 & 102	CFJ	1	1	9	5,100 lb. t.	1.06	4.45	50	97	1,620	
	Nene Mk.103	CFJ	1	1	9	5,400 lb. t.	1.07	4.45	50	78	1,612	
	RB.108	AFJ	.....	.....	A	.....	.....	.....	.....	.....	.....	VTOL Engine: Short SC.1
	Soar Mk.1	AFJ	.....	.....	A	.....	.....	.....	16	59	275	Aerfer Ariete
	Soar RSr.2	AFJ	.....	.....	A	1,860 lb. t.	.....	.....	16	59	275	
	Tyne RTy.1	AFP	.....	.....	A	4,985 eshp.	0.499	13.0	41	110	2,063	Twin Spool
	Tyne RTy.10&11	AFP	.....	.....	A	5,380 eshp.	0.479	13.0	41	110	2,063	Twin Spool

Abbreviations:

A — Annular
ACFJ — axial-centrifugal turbojet
ACFP — axial-centrifugal turboprop
CFJ — centrifugal-flow turbojet
CFP — centrifugal-flow turboprop
eshp. — equivalent shaft horsepower
ghp. — gas horsepower
lb. t. — pounds thrust
AFG — axial-flow gas generator
AFJ — axial-flow turbojet
AFP — axial-flow turboprop
BFJ — bypass turbojet



DOUBLE-ACTING "B" SERIES

PIP® SELF-LOCKING QUICK-RELEASE PINS

the pin that's designed for positive release...even under "over-load" or "bound" conditions!

Double-acting PIP Pins combine rugged strength and dependability with INSTANT INSERTION, SELF-SAFETYING... and QUICK RELEASE! Cotter pins, nuts, bolts and other retaining devices are completely eliminated. Result—unlimited design freedom and accessibility where units are frequently assembled and disassembled... permits quick-change of mechanical units... speeds assembly of portable equipment... reduces servicing costs.

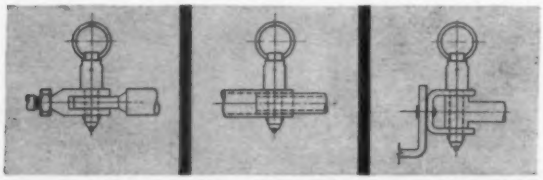
Difficult fastening applications where ordinary fastening devices may "bind" in misaligned holes or under unusually heavy loads are "made to order" situations for double-acting "B" Series PIP Pins, which operate on the fast push-to-insert—pull-to-remove principle... but have the added advantage of the exclusive PIP "drive-in"—"drive-out" spindle. It's the safest, most reliable self-locking quick-release pin available!

MEETS RIGID REQUIREMENTS

Double-acting PIP Pins are used by every major aircraft manufacturer and the military services... are specified for use in missiles... used by leading manufacturers of electronics, industrial and materials handling equipment and have proven their complete reliability in many other fields.

Get exclusive PIP Pin "drive-in"—drive-out" advantages in standard diameters to fit most nominal holes. "B" Series PIP Pins with continuous steel ring aid forcible release and adapts to remote release systems.

Use the experience and technical knowledge of our Engineering Staff to determine the right solution to your quick-release fastening problem.



Clevis fitting Tube assembly Bracket assembly

Technical data and specifications are detailed in Brochure No. ADI-5500. Write for your FREE copy today!

AVIATION DEVELOPMENTS INC.
210 S. VICTORY BLVD.
BURBANK, CALIFORNIA

Sales offices in principal cities
Manufacturers of PIP® Self-Locking Quick-Release Pins, Chobert® Rivets and Avdel Sheet Grippers.

Circle Number 145 on Reader-Service Card

Leading Foreign Gas Turbines

Manufacturer	Basic Data					Performance			Physical Data			Remarks
	Military designation	Type	No. compressor stages	No. turbine stages	No. combustors	Max. power at S.L.	Specific fuel consumption at max. power	Compression ratio at max. rpm	Diameter, inches	Length, inches	Dry weight, less reducer, lb.	
Blackburn & General Aircraft Ltd. *Brough, E. Yorks*	Palouste 500	CFG	1	2	A	2.71 lb. air/sec.	.....	3.88	21	33.5	204	Fuel flow: 330 lb./hr.
	Hi-Pres. Palouste 500	CFG	1	2	A	2.3 lb. air/sec.	.....	5.4	27	45.5	250	Fuel flow: 320 lb./hr.
	Artouste 600	CFP	1	2	A	475 eshp.	.....	.....	19	40.0	284	Fuel flow: 471 lb./hr.
	Turmo 600	CFP	1	1	A	450 eshp.	.....	.....	21	46.12	310	Fuel flow: 470 lb./hr.
	Palas 600	CFJ	1	1	A	390 lb. t.	.....	.....	18	30.07	169	Fuel flow: 465 lb./hr.
FRANCE												
Generale Aeronautique Marcel Dassault *St. Cloud (S. & O.)*	M.D.30 Viper	AFJ	7	1	A	1,630 lb. t.	1.10	3.8	27	66	496	Armstrong-Siddeley License
	M.D.30R	AFJ	7	1	A	2,205 lb. t.	2.30	3.8	27	132	761	M.D.30 w/afterburner
	R.7	AFJ	7	1	A	3,985 lb. t.	1.07	3.8	29	79	748	
Societe d'Exploitation des Materials Hispano-Suiza *Bois-Colombes (Seine)*	Nene 105	CFJ	1	1	9	5,100 lb. t.	1.06	4.45	50	96	1,610	Rolls-Royce license
	Tay 250	CFJ	1	1	9	6,280 lb. t.	1.06	4.18	50	100	1,973	Rolls-Royce license
	Verdow 350	CFJ	1	1	9	7,700 lb. t.	1.10	4.90	50	103	2,057	
	R-804	AFJ	7	1	A	3,300 lb. t.	1.07	5.00	26	83	680	
	R-854	AFJ	7	1	A	4,450 lb. t.	2.00	5.00	26	146	850	With afterburner
Societe Nationale d'Etude et de Construction de Moteurs d' Aviation *Paris*	Atar D2A & D3	AFJ	7	1	A	6,600 lb.t.	1.03	4.5	36	141	1,895	
	Atar E3	AFJ	8	1	A	7,715 lb. t.	1.05	4.8	39	162	1,851	
	Atar E4	AFJ	8	1	A	8,150 lb. t.	1.06	4.8	39	162	1,851	
	Atar E5	AFJ	8	1	A	8,150 lb. t.	1.06	4.8	39	162	1,851	
	Atar G2 & G3	AFJ	8	1	A	9,700 lb. t.	1.85	4.8	40	253	2,720	
	Atar 08	AFJ	9	2	A	9,700 lb. t.	0.98	5.2	40	181	2,180	
	Atar 09B	AFJ	9	2	A	13,250 lb. t.	2.07	5.2	42	264	2,760	Max. vel. = Mach. 2-4
Societe Turbomeca *Paris*	Palas	CFJ	1	1	A	352 lb. t.	1.17	3.95	16	47	158	
	Marbore 2	CFJ	2	1	A	880 lb. t.	1.15	3.85	25	62	314	
	Marbore 4	CFJ	1	1	A	1,000 lb. t.	1.20	3.5	25	62	300	
	Arbizon	.....	.....	2	A	552 lb. t.	0.90	5.5	21	57	236	
	Gourdon	ACFJ	2	2	A	1,545 lb. t.	1.00	5.0	24	75	386	
	Gabizo	ACFJ	2	1	A	2,400 lb. t.	1.04	5.2	21	82	585	
	Soulor	ACFJ	2	2	A	704 lb. t.	0.8	5.0	18	59	354	
	Artouste 2	CFP	1	2	A	396 eshp.	1.07	3.6	23	67	288	
	Artouste 3	ACFP	2	3	A	594 eshp.	0.65	5.5	21	58	318	
	Bastan	ACFP	2	3	A	741 eshp.	0.67	5.2	21	61	396	
	Marcadau	CFP	1	2	A	386 eshp.	1.07	3.6	22	57	350	
	Palouste 4	CFG	1	2	A	2.54 lb. air/sec.	.....	3.8	22	53	200	Fuel flow: 260 lb/hr.
	Autan 2	ACFG	2	3	A	3.0 lb. air/sec.	.....	5.1	21	54	250	Fuel flow: 350 lb/hr.
	Turmo 2	CFP	1	2	A	396 eshp.	1.07	3.9	26	49	320	
	Turmo 3	CFP	2	3	A	786 eshp.	0.72	5.5	31	66	530	
	Astazou	ACFP	2	3	A	330 eshp.	0.72	.....	18	46	234	
	Tramontane	.....	1	2	A	5.5 lb. air/sec.	.....	3.5	23	47	370	Fuel flow: 680 lb./hr.
ITALY												
FIAT-SMA *Turin*	4002	CFJ	1	1	A	550 lb. t.	1.25	4.0	22	41	220	

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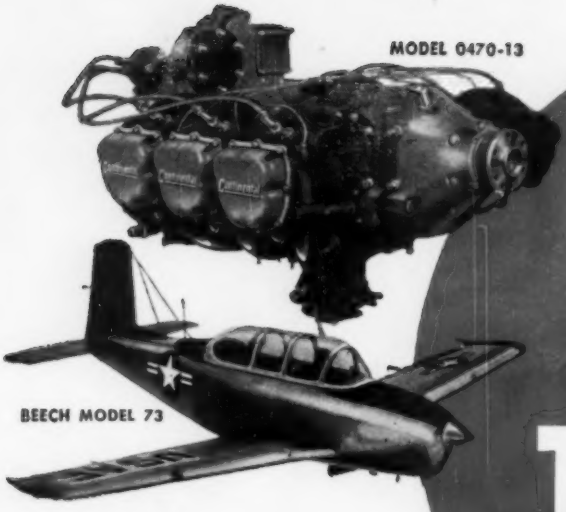
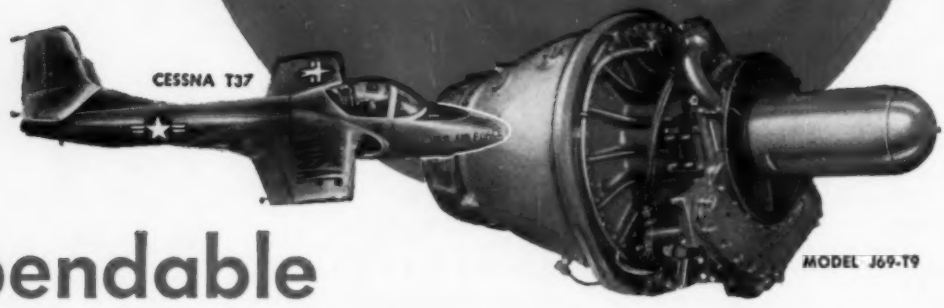
BOEING KC-135As



PISTON OR TURBINE



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Continental Motors and its CAE subsidiary are successfully meeting a wide variety of aircraft power requirements. Dependable Continental engines of piston or turbine type now power not only leading makes of fixed wing utility and trainer aircraft, but modern high-performance helicopters as well. Engine-building experience dating from 1902 clinches the "rightness" of the engine with the Continental name.

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Look ahead...join the air force

Circle Number 146 on Reader-Service Card

U. S. Gas Turbine Engines

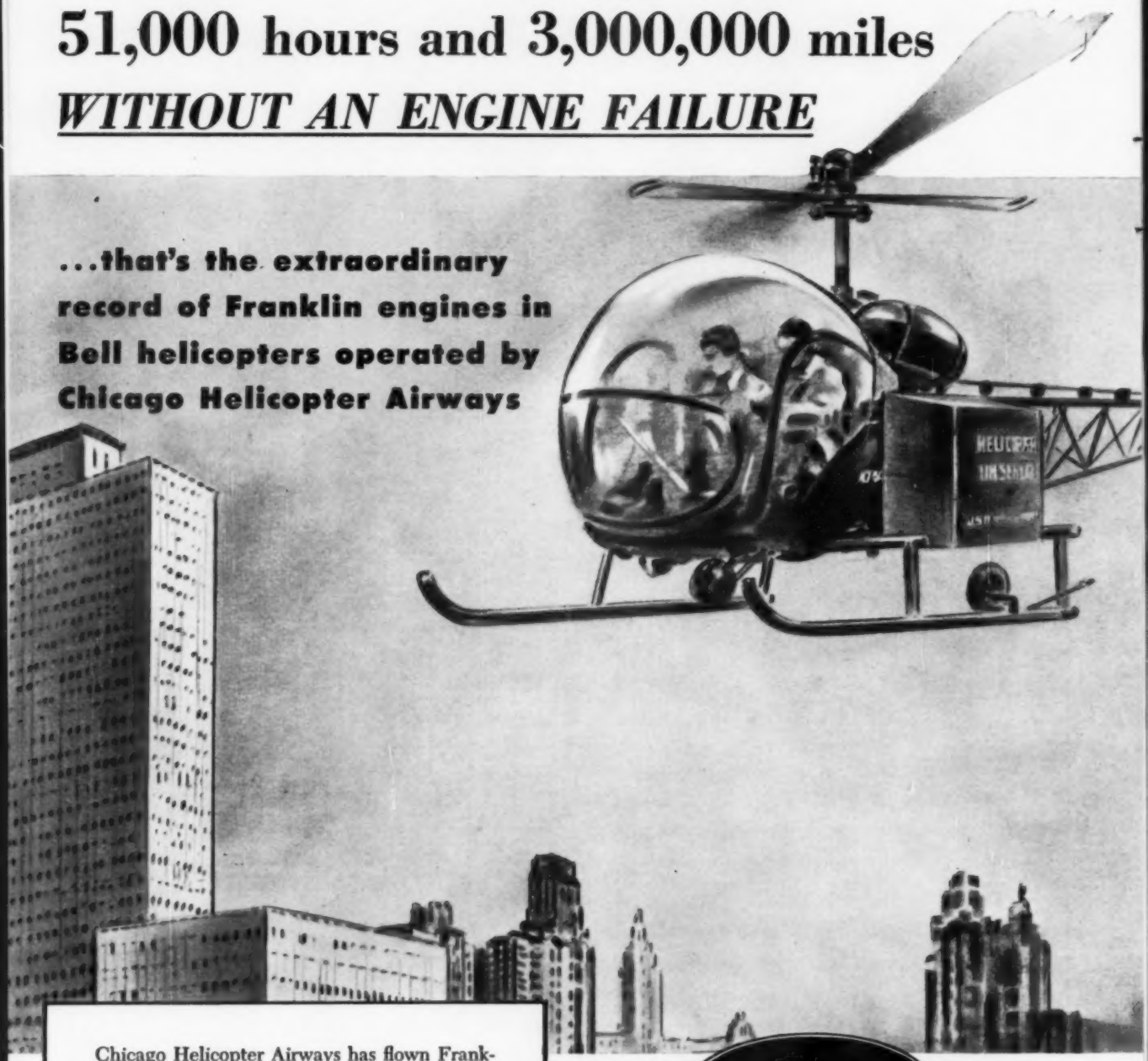
Manufacturer	Designation	Type	No. compressor stages	No. turbine stages	No. combustors	Max. power @ S.L.	Specific fuel consumption at max. power, lb./hr./lb. or sshp.	Compression ratio at max. rpm.	Max. envelope diameter, in.	Max. envelope length, in.	Dry weight, less inlet/ex., lb.	Remarks
Avco Manufacturing Corp.	T53-L-1	ACS	5+1	2	1	865 eshp.	.673	6	23	48	480	
Lycoming Division	T53-L-3	ACP	5+1	2	1	1,005 eshp.	.655	6	23	59	495	
Stratford, Conn.	T55-L-1	ACP	7+1	3	1	1,676 eshp.	.648	.....	24.25	59	695	
	T55-L-3	ACS	7+1	3	1	1,676 eshp.	.648	.....	24.25	44	690	Helicopter version: nominal output speed
Boeing Airplane Co.	520-2	CS	1	1+1	2	400 eshp.	0.72	.....	23.7	57.25	350	For Rotary wing aircraft
Seattle, Wash.	502-10C	CS	1	2	2	240 eshp.	1.0	4.1	24	48.4	330	
	502-10F	CS	1	2	2	300 eshp.	1.0	4.47	24	48.4	300	In Radioplane RP-77.
	514-2	CFG	1	1	1	388 air hp. or 293 air hp. plus 100 shp.	.....	5.5	29	41	325	Suitable for use as APU or GPU delivers bleed air and provides drive for 60 KVA alternator
	502-11B	CFG	2	2	2	210 air hp.	.....	3.5	28.5	46.1	350	
Continental Aviation and	J69-T-9, T-2	CFJ	1	1	1	920 lb. t.	1.13	.....	.....	50	364	
Engineering Corp.	J69-T-19B	CFJ	1	1	1	1,060 lb. t.	1.27	3.8	22.3	43.3	312	
Detroit, Mich.	J69-T-23	AC-J	2	2	1	.....	.....	.....	.....	.....	.....	
	T51-T-3	CFP	1	2	1	425 eshp.	0.97	.....	.....	36	236	
	324	ACJ	2	2	1	550 lb. t.	1.12	.....	.....	.....	214	
	320	CFJ	1	1	1	350 lb. t.	1.23	.....	16.5	35.5	158	
	141	CFG	1	1	1	191 air hp.	.....	.....	.....	.....	197	Fuel flow: 287 lb./hr. Suitable for pressure jet helicopters
	J87	.....	...	...	..	.....	.....	.....	.....	.....	.....	
Curtiss-Wright Corp.	J65-W-5	AFJ	13	2	1	7,200 lb. t.	.....	.....	37.5	109	2,750	
Wright Aeronautical Division	J65-W-7	AFJ	13	2	1	7,800 lb. t.	.....	.....	37.5	115	2,795	
Wood-Ridge, N. J.	J65-W-16-16A	AFJ	13	2	1	7,700 lb. t.	.....	.....	37.5	113	2,742	
	J65-W-18	AFJ	13	2	1	10,000 lb. t.	.....	.....	37.5	151	3,485	
	TJ38 Zephyr	AFJ	12	2	8	12,500 lb. t.	.718	10.5	41	121	3,600	Has sound suppressor & thrust reverser
	TJ37	AFJ	7	1	7	4,850 lb. t.	1.086	4.4	32.4	76.57	990	
	TJ34-AB1	AFJ	7	1	1	1,750 lb. t.	1.11	4.6	24.0	66.0	510	
	TP45A1	AFP	12	4	10	7,500 eshp.	.322	10.5	42.0	115.0	3,895	Twin spool compressor
	J67	AFJ	...	...	..	.....	.....	.....	.....	.....	.....	
Fairchild Engine and Airplane	J44-R-3	ACJ	1	1	1	1,000 lb. t.	1.55	2.47	24.3	90.4	380	Thrust assist powerplant for inhabited aircraft (military version)
Corp., Fairchild Engine Div.												
Deer Park, L. I., N. Y.	J44-R-20-20B-24	ACJ	1	1	1	1,000 lb. t.	1.65	2.5	24	80	348	For use in drones & missiles
	J44-R-26	ACJ	1	1	1	1,100 lb. t.	1.30	3.25	22.3	92	365	
	FT-101E	ACJ	1	1	1	1,000 lb. t.	1.55	2.47	24.3	90.4	380	Commercial J44 R-3 (certificated)
	J83	.....	...	...	..	2,000 lb. t.*	.....	.....	18	67.5	.....	
General Electric Co.	J79	AFJ	17	3	..	10,000 lb. class	.....	.....	36	204	.....	
Aircraft Gas Turbine Division	CJ-805	AFJ	17	3	..	10,000 lb. class	.....	.....	36	110	.....	Civil J79
Evendale, Ohio	T58-GE-6	ACS	10	2+1	1	1,050 shp.	.64	8	16	54	267	Figures do not include optional reduction gear.
	J85	AFS	...	...	..	2,000 lb. t.*	.....	.....	.....	.....	.....	High power/weight ratio
	T64	AFP & ACS	...	...	..	2,600 hp. class	.....	.....	.....	.....	.....	"Convertible" turboshaft/turboprop; high power/weight ratio
	Nuclear engine	.....	...	...	..	.....	.....	.....	.....	.....	.....	For Lockheed WS-1125A
	J93	.....	...	...	..	.....	.....	.....	.....	.....	.....	For WS-110A chemical bomber
General Motors Corp.	J33-A-18A	CFJ	1	1	14	4,600 lb. t.	1.14	4.35	49	94	1,790	
Allison Division	J33-A-35	CFJ	1	1	14	4,600 lb. t.	1.14	4.35	52	106	1,820	
Indianapolis, Ind.	J33-A-41	CFJ	1	1	14	5,100 lb. t.	1.14	4.35	52	156	1,520	
	J71-A-2	AFJ	16	3	..	10,000 lb. t.	.....	.....	43	285	4,017	
	D71-A-13	AFJ	16	3	..	10,000 lb. t.	.....	.....	48	191	3,829	
	T56-A-1	AFP	14	4	6	3,750 eshp.	0.54	9.25	40	145	1,645	
	501-D13	AFP	14	4	6	3,750 eshp.	0.54	9.25	36	145	1,750	
	501-D15	AFP	...	...	..	4,050 eshp.	.....	.....	.....	.....	.....	
	550	AFP	...	...	..	5,500 eshp.	.....	.....	.....	.....	.....	Split compressor
	J89	.....	...	...	..	25,000 lb. t.	.....	.....	.....	.....	.....	
United Aircraft Corp.	J48	CFJ	1	1	9	7,250 lb. t.	1.14	4	50	110	2,080	Commercial version is JT7H
Pratt & Whitney Aircraft Division	J52	AFJ	...	...	..	7,500 lb. t.	.....	.....	.....	.....	.....	Split compressor; civil version is JT9
E. Hartford, Conn.	J57	AFJ	...	...	..	10,000 lb. t.	.....	.....	.....	.....	.....	Split compressor
	J75	AFJ	...	...	..	15,000 lb. t.	.....	.....	.....	.....	.....	Split compressor
	T34	AFP	13	3	8	6,000 eshp.	0.63	6.7	34	157	2,564	
	T57	AFP	...	...	..	15,000 eshp.	.....	.....	.....	.....	.....	Split compressor
	PT2G-3	AFP	...	...	..	6,000 eshp.	0.63	6.7	34	157	2,670	Commercial T34
	JT3C-1	AFJ	...	...	..	11,000 lb. t.	.....	.....	.....	.....	.....	Commercial J57
	JT4A-3	AFJ	...	...	..	15,000 lb. t.	.....	.....	.....	.....	.....	Commercial J75
	J91 Nuclear engine	.....	...	...	..	.....	.....	.....	.....	.....	.....	For Convair WS-125A
	J58	.....	...	...	..	.....	.....	.....	.....	.....	.....	
Westinghouse Electric Corp.	J34-WE-34	AFJ	11	2	1	3,250 lb. t.	1.06	4.1	27	122	1,194	
Aviation Gas Turbine Division	J34-WE-36	AFJ	11	2	1	3,400 lb. t.	1.04	4.1	27	112	1,207	
Kansas City, Mo.	J34-WE-46	AFJ	11	2	1	3,400 lb. t.	1.06	4.1	27	112	1,242	
	J54-WE-2	AFJ	...	...	..	6,700 lb. t.	.....	.....	.....	.....	.....	High altitude engine
	XJ81-WE-3	AFJ	...	...	..	1,800 lb. t.	.....	.....	.....	.....	.....	Expendable engine for missiles and drones; Americanized R-R Soar

Abbreviations:

* — Approximate
ACJ — Axial-centrifugal turbojet
ACS — Axial-centrifugal shaft turbine
AFP — Axial-flow turboprop
CFJ — Centrifugal-flow turbojet
CS — Centrifugal shaft turbine
Eshp. — Equivalent shaft horsepower
Lb. t. — Pounds thrust
Shp. — Shaft horsepower

51,000 hours and 3,000,000 miles
WITHOUT AN ENGINE FAILURE

...that's the extraordinary record of Franklin engines in Bell helicopters operated by Chicago Helicopter Airways



Chicago Helicopter Airways has flown Franklin-powered Bell helicopters for 10 years in its pioneer helicopter air mail service in amassing this dramatic proof of Franklin engine reliability. These flights have carried more than 24,000,000 pounds of mail. 96% of all scheduled flights have been completed. There has not been a single accident during the entire period. Over the years, precautionary landings have been made, but there has never been a case of complete loss of power.

Such phenomenal reliability is perhaps the greatest single reason why *Franklin has built more helicopter engines, by far, than all other makes combined.*

Franklin

Aircooled Motors

AIRCOOLED MOTORS, INC.
SYRACUSE, N. Y.

Circle Number 147 on Reader-Service Card

U. S. Reciprocating Engines

Manufacturer and Address	Designation	No. of cylinders	Cylinder arrangement	Propeller drive	Power Ratings: Max. takeoff power (hp.) — SL	@ rpm.	Normal cruise power (hp.)	@ rpm.	@ altitude (ft.)	Altitude	Diameter or dimensions, in. (without cowling)	Gear ratio	Gross weight dry (lb.)
Aircooled Motors, Inc. *Syracuse, N. Y.*	4A4-100-B3	4	Ho	Direct	100	2,550	.....	.....	.....	SO	.....	.....	200
	6A4-150-B3	6	Ho	Direct	150	2,600	.....	.....	.....	SO	.....	.....	278
	6A4-165-B3	6	Ho	Direct	165	2,800	.....	.....	.....	SO	.....	.....	278
	6AG4-185-B12	6	Ho	G .632:1	185	3,100	.....	.....	.....	SO	.....	.....	232
	6A4-200-C6	6	Ho	Direct	200	3,100	.....	.....	.....	91	.....	.....	307
	6V4-200-C32[1], C33[1], 0335-5, -6	6	Vo	Direct	200	3,100	.....	.....	.....	91	.....	.....	297
	6V6-245-B 16F[1] O 425-1	6	Vo	Direct	245	3,275	.....	.....	.....	SO	.....	.....	372
	6V-335-A, -B	6	Vo	Direct	210	3,100	.....	.....	.....	91	.....	.....	295
Avco Manufacturing Corp. **Lycoming Division** *Stratford, Conn.*	O-235-C1	4	Ho	Direct	115	2,800	80	2,350	6,500	SO	22.53x32	.....	237
	O-290-D2B	4	Ho	Direct	140	2,800	100	2,350	6,500	SO/87	22.81x32.24	.....	294
	O-320-A1A	4	Ho	Direct	150	2,700	110	2,450	7,000	SO/87	23.12x32.24	.....	272
	O-320-B1A	4	Ho	Direct	160	2,700	120	2,450	7,000	91/96	23.12x32.24	.....	278
	O-340-A1A	4	Ho	Direct	170	2,700	125	2,450	7,000	91/86	24.68x32.55	.....	278
	O-340-B1A	4	Ho	Direct	160	2,700	120	2,450	7,000	SO/87	24.68x32.55	.....	275
	O-360-A1A	4	Ho	Direct	180	2,700	135	2,450	7,500	91/96	24.68x33.57	.....	282
	O-360-B1A	4	Ho	Direct	168	2,700	125	2,450	7,500	91/96	24.68x33.57	.....	279
	O-435-A	6	Ho	Direct	190	2,550	140	2,300	7,000	SO	29.59x32.24	.....	332
	VO-435-A1C	6	Vo	Direct	260	3,400	200	3,200	7,000	SO/87	25.19x32.32	.....	335
	VO-435-A1D	6	Vo	Direct	260	3,400	200	3,200	7,000	SO/87	25.19x33.32	.....	333
	GO-435-C2B2	6	Ho	Gear	260	3,400	180	2,750	6,000	SO/87	28.02x33.12	.....	433
	GO-480-B1A6	6	Ho	Gear	270	3,400	195	2,750	7,000	SO/87	28.02x33.12	.....	437
	GO-480-B1D	6	Ho	Gear	270	3,400	195	2,750	7,000	SO/87	28.02x33.12	.....	435
	GO-480-G1B6	6	Ho	Gear	295	3,400	210	2,750	7,000	100/130	26.34x33.12	.....	442
	GO-480-G2D6	6	Ho	Gear	295	3,400	210	2,750	6,500	100/130	28.02x33.12	.....	447
	GO-480-D1A	6	Ho	Gear	275	3,400	197	2,750	7,000	SO/87	26.34x33.12	.....	453
	GO-480-F1A6	6	Ho	Gear	275	3,400	197	2,750	7,000	SO/87	28.02x33.12	.....	443
	GSO-480-B1A6	6	Ho	Gear	340	3,400	240	2,750	10,000	100/130	29.40x33.12	.....	498
	GSO-480-B1B6	6	Ho	Gear	340	3,400	240	2,750	10,000	100/130	33.26x33.12	.....	500
	GSO-480-B1C6	6	Ho	Gear	340	3,400	240	2,750	10,000	100/130	22.56x33.12	.....	497
	O-540-A1A	6	Ho	Direct	250	2,575	190	2,350	6,000	91/96	25.81x33.37	.....	396
	GSO-580-D, 0580-1	8	Ho	G .642:1	400	3,300	260	2,750	11,500	100/130	34.22x33.18	7.91	604
	SO-580-A1B	8	Ho	Direct	400	3,300	280	3,000	11,000	100/130	24.49x33.12	7.91	578
	VSO-580-A1A*0580-3	8	Ho	Direct	400	3,300	280	3,000	11,000	100/130	30.75x33.18	7.91	591
Continental Motors Corp. *Muskegon, Mich.*	A65-8	4	Ho	Direct	65	2,300	.....	.....	.....	SO/87	.....	.....	171
	C85-12F	4	Ho	Direct	85	2,575	.....	.....	.....	SO/87	.....	.....	182
	C90-12F	4	Ho	Direct	95	2,625	.....	.....	.....	SO/87	.....	.....	186
	O300 (C145-2)	6	Ho	Direct	145	2,700	.....	.....	.....	SO/87	.....	.....	311
	O470-E	6	Ho	Direct	225	2,600	.....	.....	.....	SO/87	.....	.....	345
	O470-G	6	Ho	Direct	240	2,600	.....	.....	.....	91/96	.....	.....	466.5
	O470-H	6	Ho	Extended Direct	240	2,600	.....	.....	.....	91/96	.....	.....	510
	O470-J	6	Ho	Direct	225	2,550	.....	.....	.....	SO/87	.....	.....	415
	O470-K	6	Ho	Direct	230	2,600	.....	.....	.....	SO/87	.....	.....	438
	O470-L	6	Ho	Direct	230	2,600	.....	.....	.....	SO/87	.....	.....	438
	O470-M	6	Ho	Direct	240	2,600	.....	.....	.....	91/96	.....	.....	450
	SO470-A	6	Ho	Direct	265	2,600	.....	.....	.....	100/130	.....	10.36	522
	FSO526-A	6	Ho	G 10.04	270	3,200	.....	.....	.....	91/96	.....	10.56	568
	GSO526-A	6	Ho	G .688:1	320	3,000	.....	.....	.....	91/96	.....	.....	560
	GSO526-B	6	Ho	G .688:1	400	3,200	.....	.....	.....	100/130	.....	.....	548
Pratt & Whitney Aircraft Div. **United Aircraft Corp.** *East Hartford, Conn.*	R2000-D5	14	Rad	G .500	1,450	2,700	1,200	2,550	6,400	100/130	49.10	.....	1,585
	R2000 2SD13-G	14	Rad	G .500	1,450	2,700	1,200	2,550	5,000	100/130	49.10	.....	1,605
	R2800-CB3	18	Rad	G .450:1	2,400	2,800	1,800	2,600	8,500	100/130	52.80	.....	2,357
	R2800-CB4	18	Rad	G .450:1	2,500	2,800	1,800	2,600	8,500	108/135	52.80	.....	2,357
	R2800-CB16	18	Rad	G .450:1	2,400	2,800	1,800	2,600	8,500	100/130	52.80	.....	2,390
	R2800-CB17	18	Rad	G .450:1	2,500	2,800	1,800	2,600	8,500	108/135	52.80	.....	2,390
Wright Aeronautical Div. **Curtiss-Wright Corp.** *Wood-Ridge, N. J.*	749C18BD1 R3350-75	18	Rad	G .4375:1	2,500	2,800	1,470	2,400	11,000	100/130	55.92	6.46[5]	2,915
	826C9HD3 & 5 R1820-76A,-76B	9	Rad	G .666:1	1,425	2,700	.....	.....	.....	100/130	55.27	7.21[5]	1,380
	836C18CA2 R3350-26WB	18	Rad	G .4375:1	2,700	2,900	1,900	2,600	17,000	115/145	55.6	6.46[5]	2,953
	853C7BA1 R1300-1A	7	Rad	G .5625:1	800	2,600	.....	.....	.....	91/98	50.45	7.21	1,065
	856TC18DB1, 2[3] R3350-30WA	18	Rad	G .4375:1	3,500	2,900	.....	.....	.....	115/145	56.6	6.46[4]	3,408
	863C9HD1 R1820-103	9	Rad	Direct	1,425	2,700	.....	.....	.....	100/130	54.95	7.21[5]	1,380
	865C7BA1 R1300-2	7	Rad	Direct	800	2,600	.....	.....	.....	91/98	50.45	7.21	1,056
	867C9HE1, 2 R1820-82	9	Rad	G .5625:1	1,525	2,800	.....	.....	.....	115/145	55.74	7.21	1,445
	871C7BA1[5] R1300-3	7	Rad	Direct	800	2,600	.....	.....	.....	91/98	50.45	7.21	1,080
	872TC18DA1 R3350-34	18	Rad	G .4375:1	3,250	2,900	.....	.....	.....	115/145	56.6	6.46[4]	3,357
	878TC18EA1 R3350-32a	18	Rad	G .4375:1	3,700	2,900	.....	.....	.....	115/145	56.6	6.466[4]	3,458
	895C9HE1 R1820-84	9	Rad	Direct	1,525	2,800	.....	.....	.....	115/145	55.74	7.21	1,405
	896C9HD1 R1820-86	9	Rad	G .666:1	1,425	2,700	.....	.....	.....	100/130	55.27	7.21[5]	1,385
	923TC18DA1 R3350-91	18	Rad	G .4375:1	3,250	2,900	.....	.....	.....	115/145	56.6	6.46[4]	3,620
	932TC18EA2	18	Rad	G .355:1	3,400	2,900	.....	.....	.....	115/145	56.6	6.46[4]	3,708
	957C7BA1	7	Rad	G .5625:1	800	2,600	490	2,130	10,500	91/98	50.45	7.21	1,065
	968C9HE1	9	Rad	G .5625:1	1,475	2,800	890	2,400	13,000	100/130	54.95	7.21	1,390
	972TC18DA1, 2[6]	18	Rad	G .4375:1	3,250	2,900	1,910	2,400	11,400	115/145	56.6	6.46[4]	3,514
	975C18CB1	18	Rad	G .4375:1	2,800	2,900	1,600	2,400	12,500	115/145	56.6	6.46[4]	3,029
	976C9HE1	9	Rad	G .5625:1	1,535	2,800	890	2,400	12,200	100/130	55.75	7.21[5]	1,460
	977C9HD1[5]	9	Rad	Direct	1,425	2,700	.....	.....	.....	100/130	55.25	7.21[5]	1,349
	982C9HE1	9	Rad	G .5625:1	1,525	2,800	.....	.....	.....	115/145	55.75	7.21	1,455
	987C9HD1	9	Rad	G .666:1	1,425	2,700	975	2,500	18,300	100/130	54.95	7.21[5]	1,371
	988TC18EA-1[7]	18	Rad	G .4375:1	3,400	2,900	1,910	2,400	13,500	115/145	56.59	6.46[4]	3,699
	988TC18EA2	18	Rad	G .355:1	3,400	2,900	1,910	2,400	13,500	115/145	56.59	6.46[4]	3,745
	989C9HE1, 2[5]	9	Rad	Direct	1,525	2,800	.....	.....	.....	115/145	55.74	7.21	1,405

G —Geared
Ho —Horizontally opposed.
Rad —Radial.
SL —Sea level.
Vo —Vertically opposed.

[1] For helicopter installation.
[2] Or 10.14:1.
[3] Or 8.69:1.
[4] Or 8.67:1.
[5] 856TC18DB2 (R3350-38W) is similar but has takeoff power of 3,250 hp. and dry gross weight of 3,445 lb. 868TC18DB1 (R3350-55) and 868TC18DB2 (R3350-59) is similar to -30WA but weighs 3,438 lb. dry. Some have manifold absolute pressure regulator.
[6] DA3 is identical to DA1 except for incorporation of increased capacity main bearings, improved pistons and improved PRT cooling air impellers. DA4 identical to DA2 except for differences as listed for DA3 and DA1 engines.
[7] EA 3 is same as EA1 except for modified baffles and fuel injection line routing. EA6 is same as EA4 except for differences listed for EA3 and EA1. EA5 is similar to EA2 except for improvements which permit increased cruise power.

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ROTARY ACTUATOR
IN HYDRAULIC HISTORY!

COMPARE!

TORQUE (in-lbs)	PRESSURE (psi)	TRAVEL (Degrees)	WEIGHT (lbs)	DIAMETER (inches)	LENGTH (inches)
2,580	3,000	±30	2.8	1.5	4.25
12,550	3,000	±30	6.6	2.375	5.42
225,000	2,800	±10	43	5.437	9.68

BREAKAWAY PRESSURE (psi)	DYNAMIC BACKLASH (Degrees)	INTERNAL LEAKAGE AT 3000 PSI (GPM)	DYNAMIC SPRING CONSTANT* (in-lbs/rad)	DISPLACEMENT (in^3/rad)
12	.1	.05	$.163 \times 10^6$	.887
5	.048	.05	$.382 \times 10^6$	4.4
3	.02	.20	8×10^6	84.7

*For single ended shaft. Will be considerably greater for double ended shaft which can be supplied.

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These are only 3 of the Rotary Actuators which CLEMCO can build to suit your specific application.

COMPARE...
THEN COME TO CLEMCO!

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- Less Leakage!
- Less Weight!
- Less Backlash!
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PROPRIETARY DESIGNS OF HYDRAULIC AND PNEUMATIC UNITS FOR MILITARY AND COMMERCIAL AIRCRAFT AND MISSILES

CAP

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This is #9 of a continuing series of advertisements prepared especially for the advancement of the aircraft industry by CLEMCO. Keep a file of them so you will have the complete story of CLEMCO.

Circle Number 204 on Reader-Service Card

U. S. Civil and Military Transports

Aircraft General Data							Performance							Weights			Dimensions		
Manufacturer	Model	Name	No. of crew	No. of passengers	Cargo capacity, lb.	Number, make, model of powerplants	Maximum speed, mph.	Best cruise speed, mph.	Landing speed, flaps and landing gear down, mph.	Engine-out enroute climb, fpm.	CAA field length takeoff, ft.	CAA field length landing, ft.	Maximum still-air range, mi.	Weight empty, lb.	Maximum gross weight, lb.	Maximum landing weight, lb.	Wingspan	Overall length	Maximum height
Boeing Airplane Co.	707-120	Jet Stratoliner	3	110-130	1,235	4 P&W JT3C-6[1]	.....	600	.....	.....	.....	.....	4,000	111,082	248,000	175,000	130' 10"	134' 6"	37' 7"
	707-120	Jet Stratoliner	3	124-150	1,600	4 P&W JT3C-6[1]	.....	600	.....	.....	.....	.....	4,000	113,640	248,000	175,000	130' 10"	144' 6"	38' 7"
	707-220	Jet Stratoliner	3	124-150	1,600	4 P&W JT4A-3[2]	.....	600	.....	.....	.....	.....	4,000	117,400	248,000	175,000	130' 10"	144' 6"	38' 7"
	707-320	Intercontinental	4	131-162	1,700	4 P&W JT4A-3[2]	.....	600	.....	.....	.....	.....	5,000	131,364	296,000	195,000	142' 5"	152' 11"	38' 8"
	707-420	Intercontinental	4	131-162	1,700	4 R-R Co. 10[2]	.....	600	.....	.....	.....	.....	5,000	129,900	296,000	195,000	142' 5"	152' 11"	38' 8"
	720	.....	3	110-130	1,235	4 P&W JT3C-7[2]	600+	.....	.....	.....	.....	.....	.....	103,145	203,000	165,000	130' 10"	134' 6"	37' 7"
	KC-135A	Stratotanker	4	80+	50tons	4 P&W J57	600+	.....	.....	.....	.....	.....	.....	.....	250 000	.....	130' 10"	136' 3"	38'
Convair Division General Dynamics Corp.	440[3]	Metropolitan	4	44-52	5,400	2 P&W R2800-CB-17	310	289	85	150	5,000	4,010	2,752	31,305	49,100	47,650	105' 4"	79' 2"	28' 2"
	880	.....	5	88-109	8,630	4 GE CJ805-3	615	615	138	NA	7,700	6,000	3,250	82,100	178,500	132,800	120'	129' 4"	36'
	C-131A	Samaritan	3	.....	.....	2 P&W R2800-99W	312	.....	.....	.....	.....	.....	.....	29,000	43,575	.....	91' 9"	74' 8"	27' 3"
	C-131B	.....	.....	.....	.....	2 P&W R2800-99W	295	.....	.....	.....	.....	.....	.....	29,248	47,000	.....	105' 4"	79' 2"	28' 2"
	YC-131C	.....	3	.....	.....	2 All. YT56-A-3	366	.....	.....	.....	.....	.....	.....	.....	47,000	.....	105' 4"	79' 2"	28' 2"
	C-131D	.....	3	.....	.....	2 P&W R2800-CB16	314	.....	.....	.....	.....	.....	.....	29,000	46,500	.....	105' 4"	79' 2"	28' 2"
	C-131E	.....	3	.....	.....	2 P&W R2800-103W	310	.....	.....	.....	.....	.....	.....	31,735	49,100	.....	105' 4"	79' 2"	28' 2"
	R3Y-2	Tradewind	6	.....	.....	4 All T40-A-10	350	.....	.....	.....	.....	.....	.....	.....	160,000	.....	145' 9"	139' 8"	51' 5"
	R4Y-1	.....	3	.....	.....	2 P&W R2800-52W	.....	.....	.....	.....	.....	.....	.....	30,684	47,000	.....	105' 4"	79' 2"	28' 2"
Douglas Aircraft Co., Inc.	DC-6A	Liftmaster	3-5	Cargo	30,500	4 P&W R2800-CB-17	370	315	97	493	6,100	5,160	5,000	51,316	107,000	88,200	117' 6"	106' 6"	28' 8"
	DC-6B	(domestic version)	5	54	16,780	4 P&R 2800-CB-16	370	315	95	460	5,680	4,995	3,720	55,357	100,000	85,000	117' 6"	106' 6"	28' 8"
	DC-6B	(overwater version)	7[3]	89	11,930	4 P&W R2800-CB-17	370	315	97	493	6,100	5,160	5,000	58,340	107,000	88,200	117' 6"	106' 6"	28' 8"
	DC-7	(domestic version)	3	69-99	12,740	4 Wr 972TC18DA4	409	367	.....	448	6,060	5,840	4,430	64,480	122,000	97,000	117' 6"	108' 11"	28' 7"
	DC-7B	(overwater version)	3	69-99	17,730	4 Wr 972TC18DA4	412	360	.....	525	6,350	5,870	5,120	68,073	126,000	102,000	117' 6"	108' 11"	28' 7"
	DC-7C	Seven Seas	3-5	62-99	18,440	4 Wr 988TC18EA4	406	371	.....	507	5,590	5,360	6,010	72,643	143,000	109,000	127' 6"	112' 3"	31' 10"
	DC-8	(JT3C domestic)	3	116-176	13,900	4 P&W JT3C-6	.....	582	138	760	9,170	6,540	5,035	122,698	265,000	189,000	139' 9"	150' 6"	42' 4"
	DC-8	(JT4A domestic)	3	116-176	.....	4 P&W JT4A-3	.....	589	138	1,640	7,020	6,540	4,540	125,689	265,000	189,000	139' 9"	150' 6"	42' 4"
	DC-8	(JT4A overwater)	3-5	132-176	.....	4 P&W JT4A-3	.....	589	139	1,440	8,400	6,690	6,010	130,052	287,500	190,500	139' 9"	150' 6"	42' 4"
	DC-8	(Conway overwater)	3-5	132-176	.....	4 R-R Co. 10	.....	591	139	1,810	8,480	6,690	6,020	128,042	287,500	190,500	139' 9"	150' 6"	42' 4"
	C-124C	Globemaster 2	5-8	.....	.....	4 P&W R4360-63A	304	.....	.....	.....	.....	.....	.....	101,165	185,000	.....	174' 2"	130'	48' 4"
	C-133A	.....	4-7	.....	.....	4 P&W T34	.....	.....	.....	.....	.....	.....	.....	110,881	282,000	.....	179' 8"	152' 8"	48' 3"
Fairchild Aircraft Division	F-27	Friendship	3	40	8,887	2 R-R Rda. 6 Mk. 511	280	...	79	.....	.....	.....	.....	22,476	35,700	34,000	95' 2"	77' 1"	27' 6"
	C-119G	Flying Boxcar	5	.....	.....	2 Wr. R3350-85W	293	.....	.....	.....	.....	.....	.....	39,920	74,400	.....	109' 3"	86' 6"	26' 3"
	C-123B	Provider	2	60	15,323	2 P&W R2800-99W	200	.....	.....	.....	.....	.....	.....	32,773	60,000	.....	110'	76' 3"	34' 1"
Grumman Aircraft	TF-1	Trader	2	.....	3,500	2 Wr. R1820-82	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	69' 8"	42'	16' 3"
Lockheed Aircraft Corp.	1049G[4]	Super Constellation	5-11	47-99	.....	4 Wr 972TC18DA3	370	335	101	630	6,300	5,250	5,580	73,016	137,500	113,000	123' 5"	116' 2"	24' 9"
	1049H[4]	Super Constellation	5-11	Cargo	40,000	4 Wr 972TC18DA3	370	335	101	630	6,300	5,250	5,580	70,000	137,500	113,000	123' 5"	116' 2"	24' 9"
	1649A	Starliner	5-11	47-99	.....	4 Wr 988TC18EA2	377	350	101	580	6,520	6,050	6,400	85,563	156,000	123,000	150'	116' 2"	24' 9"
	188	Electra	3-6	66-91	.....	4 All 501-D13	448	407	101	730	5,250	4,960	2,740	55,993	113,000	95,656	99'	104' 7"	32' 1"
Marietta, Ga., Div.	282A	Hercules	3	.....	44,850	4 All. 501-D22	370	335	116	970	4,700	5,200	2,800	63,370	140,250	117,250	132' 7"	97' 9"	38' 1"
	C-121C	Super Constellation	5	.....	.....	4 Wr. R3350	376	.....	.....	.....	.....	.....	.....	133,000	.....	.....	123' 5"	116' 2"	24' 9"
	YC-121F	Super Constellation	4	.....	.....	4 Wr. R3350	430	.....	.....	.....	.....	.....	.....	72,219	169,800	.....	117'	116' 2"	24' 6"
	C-130A	Hercules	4	.....	35,000	4 All. T56-A-1A	360	350	106	1,230	.....	.....	2,450	61,000	124,300	.....	132' 7"	97' 9"	38' 1"
	C-130B	Hercules	4	.....	35,000	4 All. T56-A-7	385	370	117	1,100	.....	.....	3,460	67,200	135,000	.....	132' 7"	97' 9"	38' 1"
North American Aviation, Inc.	UTX	Sabreliner	2	4-8	2,500	2 GE J85	575	400	.....	.....	.....	.....	1,380	8,153	15,330	.....	42' 6"	43' 9"	16' 6"
Stroukoff Aircraft Corp.	YC-134A	Avitruc	2	73	30,000	2 Wr. R3350-89A	285	.....	.....	.....	.....	.....	.....	37,380	81,700	.....	110'	82' 1"	34' 8"

Abbreviations:
All—Allison Division, GMC.
GE—General Electric
P&W—Pratt & Whitney Division, UAC.
R-R—Rolls-Royce, Ltd.
Wr—Wright Aeronautical Division.

Footnotes:
[1] Wet engine.
[2] Dry engine.
[3] Includes two cabin attendants.
[4] Production discontinued scheduled March 1958.
[5] Canadair to take over production.

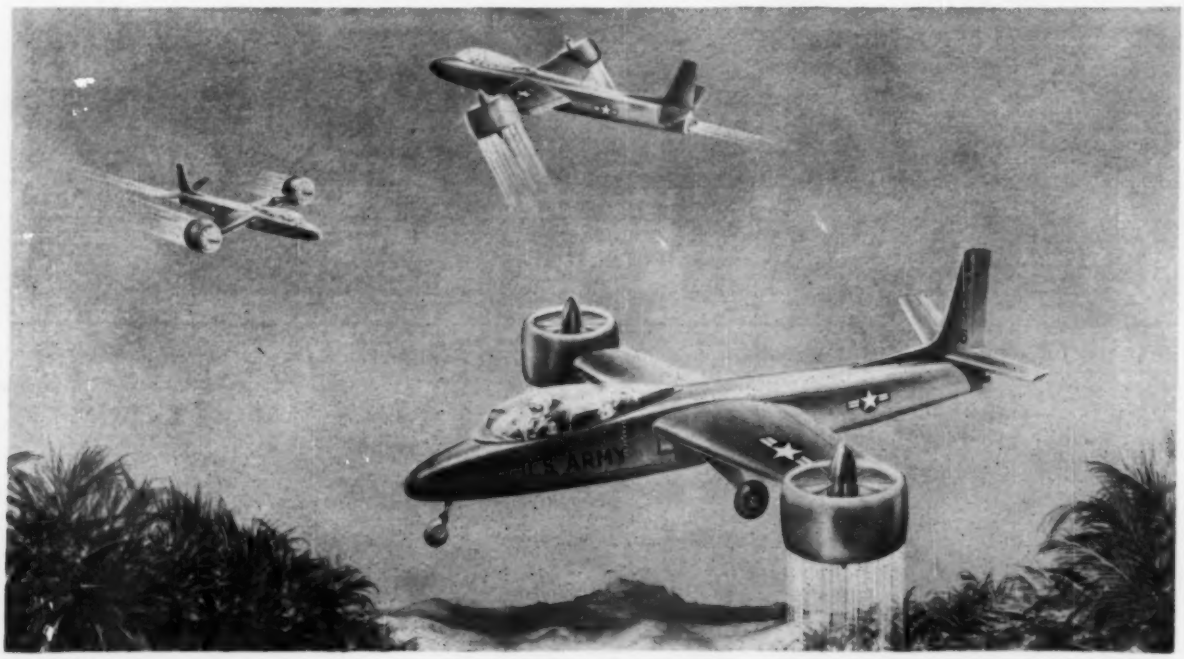
LOCKHEED ELECTRA

● SPECIFICATIONS

U. S. VTOL Aircraft

General Data				Dimensions				Weights		Powerplant	Performance					Remarks
Manufacturer	Designation	Type	No. of seats	Span	Length	Height	Wing area, sq. ft.	Empty, lb.	Gross, lb.	Number, make, model and max. power	Propeller, diameter, ea., in.	Initial rate of climb, fpm.	Hovering ceiling, ft.	Service ceiling	Maximum speed @ SL, mph.	
Bell Aircraft Corp. *Buffalo, N. Y.*	X-14	Deflected Jet	1	34′	25′	8′	..	.....	.....	2 AS Viper	None	.....	..	.....	....	First hover flight: 2-19-1957
De Lackner Helicopters, Inc. *14 N. Bleeker St.* *Mt. Vernon, N. Y.*	DH-4 Aerocycle	.....	1	.....	.....	7½′	..	221	480	1 Kiek. Mercury @ 42 hp.	180	.....	..	.....	....	Two two-blade contra-rotating.
Doak Aircraft Co., Inc. *2329 S. Western Ave.* *Torrance, Calif.*	X-16	Ducted Fan	2	26′	32′	10′	..	2,000	2,600	1 Lyc. T53 @ 840 eshp.	.....	.....	..	.....	....	Wingtip-mounted ducts.
Fairchild Aircraft Div. Fairchild E & A Corp. *Hagerstown, Md.*	M-224-1	Vectored Slipstream	1	.....	.....	.....	..	.....	.....	1 GE T58@ 1,000 eshp.	.....	.....	..	.....	....	Four propellers
Fletch-Aire, Inc. *Newton, N. J.*	Flying Jeep	Ducted Fan Ducted Fan	1 4	.....	.....	.....	58 ..	.....	1,500 6,000	2 piston @ 115 hp. 2 Lyc. T53 @ 840 eshp.	.....	1,080 1,780	.. ..	 27,600	235 215	Duct rotates 90 deg. Projected weapons carrier
Hiller Helicopters, Inc. *Palo Alto, Calif.*	VZ-1E X-18	Ducted Fan Tilt Wing	1 ..	.....	.....	.....	.. ..	.....	 33,000	3 Nelson H59 @ 40 hp. 2 All. YT40-A-L4. @	.....	.....	.. ..	....	....	Flying platform Converted Chase YC-122
Kaman Aircraft Corp. *Bloomfield, Conn.*	K-16	.....	..	.....	.....	.....	..	.....	.....	turbine	.....	.....	..	.....	....	
A. M. Lippisch Collins Radio Co. *Cedar Rapids, Ia.*	Aerodyne	Internal Airflow	..	None	.....	.....	..	.....	.....	.....	.....	.....	..	.....	....	Numerous configurations
Robertson Aircraft Corp. *Ft. Worth, Tex.*	.....	Vectored Slipstream	4	.....	.....	.....	..	.....	.....	2 Lyc. GSO480 @ 340 hp.	.....	.....	..	.....	....	Tethered flights started 1-8-1958
Ryan Aeronautical Co. *San Diego, Calif.*	X-13 Vertijet Vertiplane	Mod. Tail Sitter Vectored Slipstream	1 2	21′ 23′ 5″	24′ 27′ 8″	15′ 10′ 8″	.. ..	.....	.....	1 R-R Avon 1 Lyc. T53 @ 850 eshp.	None	.....	.. ..	....	....	Takes off, lands on tilting platform Fuselage engine turns 2 props
Vertol Aircraft Corp. *Morton, Pa.*	Model 76	Tilt Wing	2	.....	.....	.....	..	.....	.....	1 Lyc. T53 @ 825 eshp.	.....	.....	..	.....	....	Fuselage engine turns 2 props

Abbreviations:
All. — Allison
AS —Armstrong Siddeley
GE — General Electric
Kiek. — Kiekhaefer
Lyc. — Lycoming
R-R — Rolls-Royce



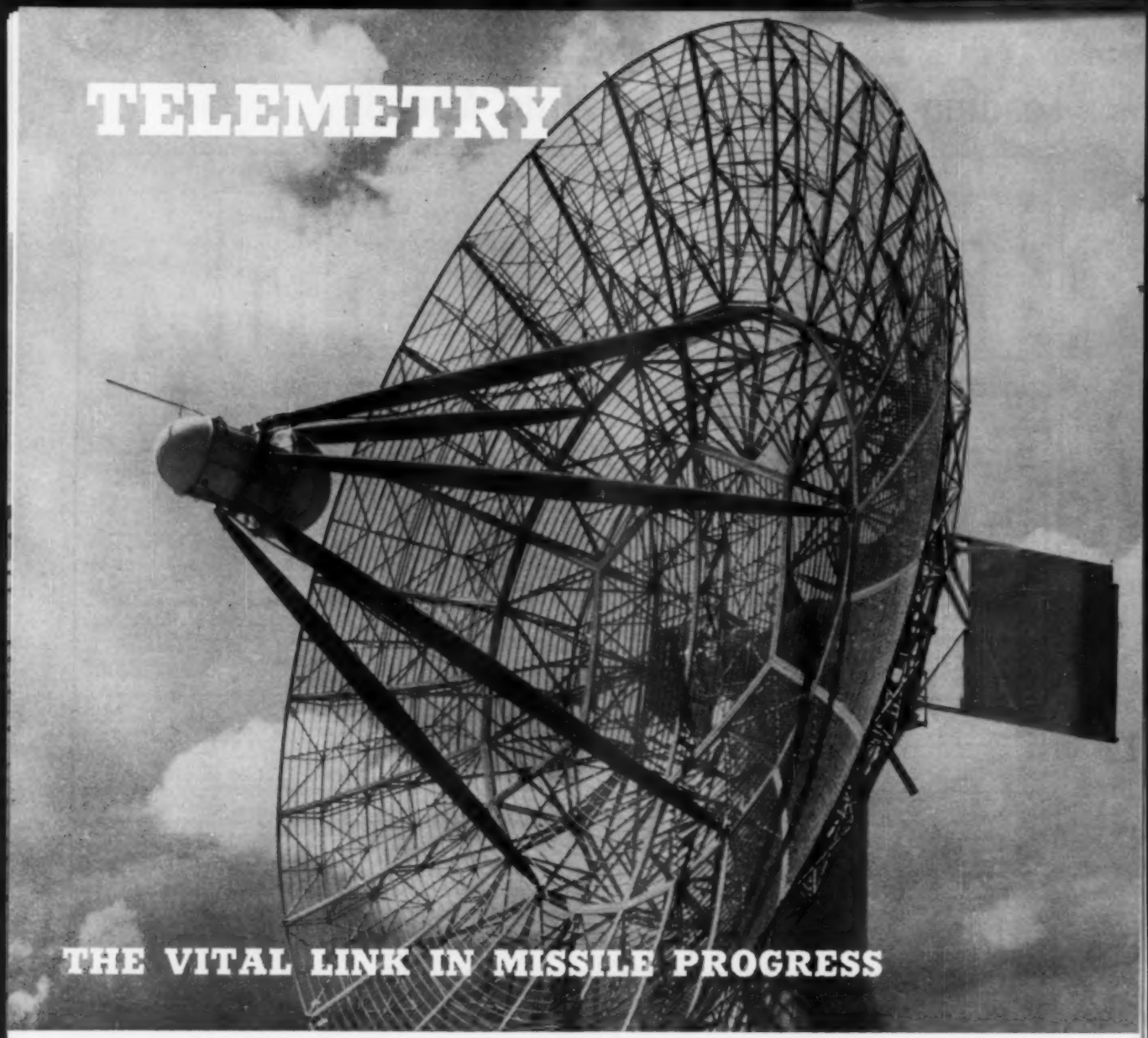
DOAK X-16

Leading Foreign Rotary-Wing Aircraft

Manufacturer and address	Model designation	Aircraft name	Seats, incl. crew	Rotor diameter	Length, blades unfolded, ft.	Max. height, ft.	Weight empty, lb.	Normal gross weight, lb.	Number, manufacturer, designation and max. rating of powerplant	Fuel capacity, gal.	Maximum speed, mph.	Initial rate of climb, fpm.	Hovering ceiling in ground effect, ft.	Service ceiling, ft.	Maximum still-air range, mi.	Remarks
GERMANY																
Prof. Heinrich Focke *Bremen*	.....	.....	3	.....	.....	.....	.....	.....	1 Lyc. VO435A1A @ 260 hp.	.....	.....	.....	.....	.....	.....	Single rotor
	.....	.....	40	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	Project
Bode Franke	.....	Volkscopter	3	.....	.....	.....	.....	.....	1 @ 105 hp.	.....	.....	.....	.....	.....	.....	Coaxial rotors
GREAT BRITAIN																
Bristol Aeroplane Co., Ltd. *Filton, Bristol*	171 Mk. 4	Sycamore	5	48.6	61.4	10.1	4,150	5,500	1 Al. Leonides 524/1 @ 520 hp.	89	127	1,300	8,400	15,500	368	
	173 Mk. 3	.....	16	48.6	89.8	17.0	9,714	13,498	2 Al. Leonides Major @ 850 hp.	290	127	1,400	10,000	16,000	348	Development for MoS military copter
	192	.....	27	48.8	89.2	17.0	9,846	18,000	2 Napier Gazelles @ 1,300 eshp.	560	138	1,175	8,000	13,250	450	
Fairey Aviation Co., Ltd. *Hayes, Middlesex*	.....	Rotodyne	50	90.0	.....	22.2	.....	39,000	2 Napier Eland @ 3,500 eshp. and 4 Fairey Tip Pressure Jets	.....	185	2,000	.....	.....	600	
	.....	Jet Gyrodyne	4	60.0	.....	.....	.....	.....	1 Al. Leonides @ 525 hp. and 2 Fairey Tip Pressure Jets	.....	.....	.....	.....	.....	.....	
	.....	Ultra Light	2	28.0	.....	8.2	960	1,800	1 Blackburn Palouste @ 280 ghp. 2 Fairey Tip Pressure Jets	.....	105	1,300	10,000	.....	185	Piasecki has U.S. sales rights
Saunders Roe, Ltd. *Osborne, E. Cowes*	.....	Skeeter Mk. 6	2	32.0	31.0	10' 2"	1,626	2,150	1 DH Gipsy Major 200 @ 200 hp.	23	101	1,020	4,100	11,900	237	Training and liaison
Westland Aircraft, Ltd. *Yeovil, Somerset*	WS-51	Dragonfly	4-5	49.0	.....	13.0	4,235	5,700	1 Al. Leonides @ 525 hp.	70	...	750	.....	.....	220	Sikorsky license
	WS-55	Whirlwind	8-10	53.0	.....	13.3	4,990	7,500	1 P&W R1340-40 @ 600 hp.	145	111	910	7,800	.....	430	Sikorsky license
	.....	Widgeon	9-12	49.2	57.3	12.9	4,322	5,600	1 Al. Leonides @ 515 hp.	83	95	700	7,800	10,000	300	
	.....	Wessex	....	56.0	65' 10"	14.3	.....	12,600	1 Napier Gazelle @ 1400 hp.	.....	.....	.....	.....	.....	.....	
	.....	Westminster	42	72.0	.....	.....	.....	33,000	2 Napier Eland @ 4,200 hp.	.....	.....	.....	.....	.....	.....	
FRANCE																
Sud-Est Aviation *Paris*	S.E.3120	Alouette	2	38.3	34.6	9.6	1,650	2,750	1 Salmson 9 N H @ 200 hp.	32	78	885	.....	.....	.....	
	S.E.3130	Alouette II	5	38.5	31.8	9.0	1,810	3,300	1 Turbomeca Artouste II @ 400 hp.	152	106	880	3,300	9,500	346	
Ouest Aviation *Paris*	S.O.1110	Ariel 3	3	35.4	24.6	.....	1,496	2,750	1 Turb. @ 275 eshp.	.....	102	.....	5,900	.....	155	
	S.O. 1221	Djinn	2	32.8	17.4	9.6	682	1,540	1 Turb. Palouste @ 528 eshp.	.....	82	.....	3,280	.....	310	
	S.O. 1310	Farfadet	4	36.7	.....	.....	.....	.....	1 Turb. Artouste 2 @ 360 eshp.	.....	150	.....	.....	.....	240	
ITALY																
Aer Lualdi & Co. *Rome*	L. 55	.....	4	32.8	39	9.5	1,321	2,202	1 Lyc. O360 @ 180 hp.	31	95	984	9,186	13,123	250	
NETHERLANDS																
Nederlandse Helicopter Industrie N.V., *Rotterdam*	H-3	Kolibrie	2	32.8	32.8	8.4	550	1,550	2 N.H.I. TJ-5 @ 60 hp.	106	70	800	6,000	.....	.....	
SPAIN																
Aerotecnica, S. A. *Madrid*	AC-12	.....	2	28.0	28.0	9.0	1,058	1,653	1 Lyc. O-360-B2A @ 168 hp.	26.4	75	850	5,800	13,000	250	
	AC-13	.....	3	29.7	29.7	9.0	1,268	1,962	1 Turb. Artouste I @ 280 shp.	31.7	93	984	8,700	19,000	168	
	AC-14	.....	5	31.5	33.5	9.5	1,400	2,645	1 Turb. Artouste II @ 400 shp.	79.3	124	1,575	12,140	30,840	400	
	AC-21	.....	12	55.6	56.0	13.5	4,410	8,820	2 Turb. Turmo III @ 750 shp.	372	124	1,770	13,800	32,000	1,000	

Abbreviations:
Al.— Alvis.
DH — de Havilland.
Lyc.— Lycoming.
MoS — Ministry of Supply.
N.H.I.— Netherlands Helicopter Industries.
P&W — Pratt & Whitney Aircraft.
Turb.— Turbomeca.

LOCKHEED F-104A STARFIGHTERS



Missiles are test fired for only one purpose: to obtain data that will help build better missiles. If the test does not yield this information it must be considered unsuccessful — regardless of how well the "bird" performed.

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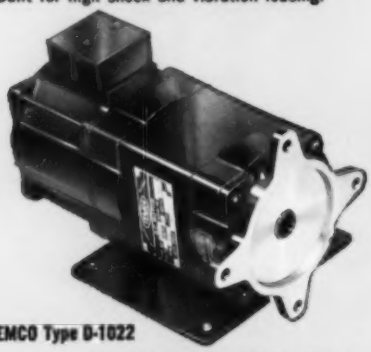
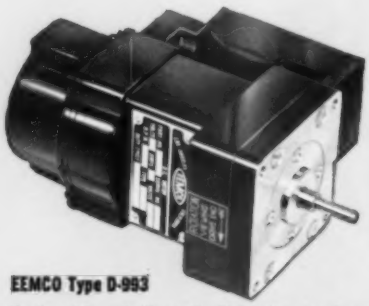
To design and produce motors for missiles that perform well beyond the limits of military specifications yet which maintain specified size and weight limitations is a constant objective at EEMCO. The design, development and testing of motors that achieve these extreme performance characteristics requires EEMCO to conduct company-financed independent research far beyond that normally conducted by a manufacturer of its size. In many instances EEMCO has been able to meet rigid specifications, in fact exceed them, when other producers have failed. For example, three of these extremely rugged new EEMCO motors illustrated will perform with reliability in the atmospheric conditions encountered at altitudes in excess of 200,000 feet, and they are built for unusually high shock and vibration loading. Please note the outstanding capabilities of the individual motors shown.



EEMCO Type D-1022

Designed by EEMCO for extremely high altitude operation with ambient temperature capacity to 165° F. Type D-1022 is capable of unusually high shock and vibration loading.
SPECIFICATIONS: Volts: 56 volts DC. **Horsepower:** 8.5 HP at 85% efficiency. **R.P.M.:** 12,000. **Duty cycle:** Two minutes. **Ambient temperature:** 165° F. **Weight:** 14.75 pounds. **Military Specifications:** Explosion proof requirement meets MIL-5272A-Proc. 2. **Features:** Built for high shock and vibration loading.



EEMCO Type D-993

Designed for missile applications where prolonged testing is necessary. Type D-993 will stand long idling periods with intermittent loads up to 1.25 HP. It is capable of withstanding vibrational accelerations of up to 125 "G's" in a frequency spectrum of 30 to 300 cycles per second.
SPECIFICATIONS: Volts: 28 volts DC (24 to 32 volt range). **Horsepower:** .65 HP. **R.P.M.:** 9600 RPM. **Weight:** 6.2 pounds. **Military Specifications:** Radio noise filter meets MIL-I-6181B. Explosion proof requirement meets MIL-5272A-Proc. 2. **Altitude Operation:** Tested successfully at over 200,000 feet altitude. **Features:** Built for high shock and vibration loading.

EEMCO Type D-899

Rated at 2.75 HP on continuous duty, EEMCO Type D-899 200-volt 400-cycle 3-phase motor is made with high temperature insulation allowing continuous operation at 3.5 HP or a correspondingly high ambient. D-899 contains an integral gear box.
SPECIFICATIONS: Volts: 200 volts, 400 cycle, 3-phase. **Load:** 2.75 HP continuous duty. **R.P.M.:** 3140 RPM. **Power Factor:** 83%. **Overall Efficiency:** 76% for entire unit including gear box. **Military Specifications:** Meets MIL-M-7969A (ASG). **Weight:** 11.25 pounds. **Features:** Type D-899 may be made splash- and drip-proof with minor alterations. Gear box, acting as motor support, places base at approximately the center of gravity of a motor-pump assembly thereby limiting extreme shocks and vibrations encountered in a missile.

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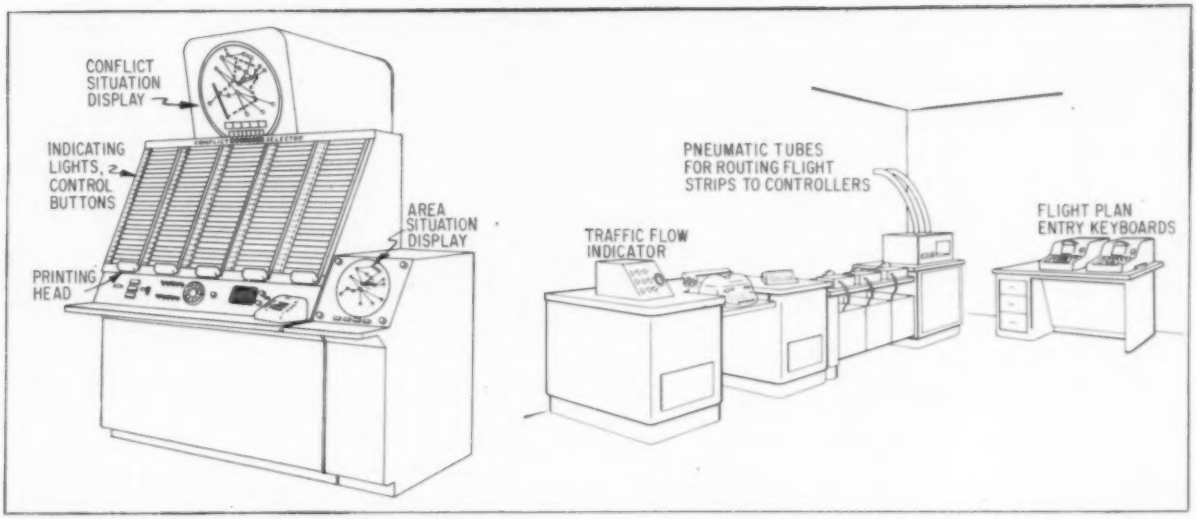

TRAFFIC controller station (left) in new data processing system which General Precision Laboratory is developing for Airways Modernization Board. Right: Flight plans will be entered into traffic control computer by teletype from airline-military operations centers or manually introduced by keyboard when received by voice. Pneumatic tubes distribute strips to controllers.

New Techniques Aimed At Jet Control

By Philip J. Klass

Washington—Airways Modernization Board is moving rapidly to evaluate and apply a variety of promising avionic techniques in its search for ways to bring the nation's traffic control system abreast of jet-age needs. One of the most important programs, only recently launched, is the development of a semi-automatic traffic control data processing system.

More immediate relief from pressing traffic control problems should come in 1958 as the Civil Aeronautics Administration installs and/or puts into initial operation a number of new avionic aids.

For example:

• **Radar beacons** will go into trial use in New York, Washington and Chicago areas, enabling traffic controllers for the first time to quickly and positively identify aircraft blips on their radar scopes. Number of airliners operating into these areas already are equipped with the airborne transponders.

• **En route traffic control radar,** first of the new long-range Raytheon sets, will go into operation this summer at CAA's Technical Development Center in Indianapolis where operational techniques will be checked-out. Most of the remaining 27 radars are slated to be installed by year-end, in operational use shortly thereafter. These new en route radars, supplemented by air defense radar data remoted into CAA centers, should provide improved traffic flow along major airways and increase airway capacity by reducing existing separations.

• **Bright radar display,** French-developed system which permits viewing in well-lighted rooms, is scheduled for use later this year. System also enables controllers to superimpose aircraft identification, airways or other helpful visual aids on the radar scope.

• **Peripheral (remote) VHF** communications, which will blanket nation at altitudes above 15,000 ft., will enable pilots to talk directly with traffic controllers, eliminating third-party transmission delays. Network should be operational by late spring.

• **First operational Vortac stations** should go into use this year, with total of several hundred in operation by mid-1959. Airlines are expected to begin to place orders for airborne Vortac distance measuring equipment this year.

The year 1958 also will establish whether an infrared proximity warning system and/or modification of existing airborne weather radar can provide worthwhile assistance in easing the air collision problem. However, if up-coming flight tests are favorable, they will not end the search for a more complete solution.

If tests are not favorable, even stronger pressures will be felt by avionics manufacturers to come up with a workable solution.

In refreshing contrast to the past, Airways Modernization Board program to date has been characterized by "action." Within 30 days after the agency was created, it was asking industry for proposals for a semi-automatic traffic control data processing system. Three months later AMB had completed its design competition and selected a contractor—General Precision Laboratory.

Instead of forming still another committee to study the problem of helicopter navigation aids, AMB has acted to set up a Decca chain in the New York area which can be evaluated by pilots of New York Airways in its daily helicopter service.

Choice of Decca for these tests does not mean that AMB has prejudged it to be superior to several other types of hyperbolic navigation systems, AMB chairman E. R. Quesada emphasizes. Rather, AMB wanted to obtain a speedy evaluation of claims and counter-claims made by proponents and opponents of low-frequency hyperbolic systems and the Decca system was immediately available through Bendix Aviation's Pacific Division (U. S. Licensee).

To supplement pilot reactions with quantitative measurements, Airborne Instruments Laboratory has been brought into the evaluation program.

Air-Ground Data Link

Another example of AMB's drive for action is air-ground data link which has been discussed for Common System use for more than 10 years. Several months ago Wright Air Development Center planned to award a sizable number of contracts for four-month studies of the

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relative technical merit of different data link techniques for possible Common System use.

AMB canceled these plans because it believes the most pressing need is to determine exactly what is required from an operational standpoint for a Common System data link. To obtain this information, AMB soon will ask industry for proposals for some experimental data link equipment which can be flight tested and used in actual traffic control operations, according to James L. Anast, acting technical director of AMB.

General Precision Laboratory will participate in program since its data processing system must tie-in with the air-ground data link.

Airways Modernization Board is pushing the addition of more radar beacon codes to provide traffic control computers with data on aircraft altitude in the terminal area. AMB also is investigating several three-dimensional military radars which provide altitude as well as bearing and range information. Agency hopes to obtain loan of such equipment for evaluation.

With number of military engineers and operations people on AMB staff, agency is in a good position to keep abreast of new military developments and hopes to apply them, where applicable, to Common System with minimum of delay.

Voice Data Link

Agency also hopes to evaluate the military developed "canned-voice" data link to see if it can speed and simplify issuance of voice clearances by traffic controllers. The technique employs magnetic drum upon which are stored oft-used words needed for routine clearance instructions. Traffic controller need only push one or more buttons to cause the voice data link to transmit desired clearance. Technique also appears promising at international airports where clearances can be pre-recorded in several languages. (AW July 16, 1956, p. 89.)

Responsibility for certain developments previously carried out by military which must be compatible and integrated with Common System, such as Air Force's Rapcon II (radar approach control center), is being turned over to AMB.

In addition to its hardware programs, AMB has or will soon launch a variety of systems and operations analysis studies. One, under way at McClellan AFB is running tests on highspeed runway turn-offs. Another involves operations analysis of traffic flow at major terminals to find out the causes of serious traffic jams and delays. Still another representative program involves analysis of air-ground conversations, radio discipline.

AMB's search for a site in which it can set up equipment for system experimentation has been narrowed down to three possible locations. Final selection is expected momentarily. Once this has been done, AMB will move to set up navigation, landing aids, radar, communications facilities. Facility probably will begin operations late this year, be fully operational by January 1960, Anast predicts.

Compared to the Air Navigation Development Board, AMB has a sizable budget. Figure for Fiscal 1958 is around $15 million and agency is seeking about $35 million for next fiscal period. However, this is not a large sum when stacked up against job that AMB is expected to do.

Restrained Datamation

Traffic control data processing system which General Precision Laboratory expects to have assembled by early 1959 will not be as fully automatic as the state-of-the-art might permit. This is intentional. Airways Modernization Board and its contractor recognize that system must be designed to permit easy transition from present, long-used procedures and practices.

Furthermore, since it is planned to use the initial system in traffic control operations in the New York area, it must be designed to permit controllers to quickly and safely revert to old procedures in event of avionic equipment failure, according to Col. Carl B. Fisher, AMB project manager.

For this reason, GPL's system will retain the long-used flight progress strips for traffic controllers—but with one important modification. Strips will be prepared by automatic printers and will be mounted on a posting board equipped with a novel printing head which can type out revisions in flight plan data after initial strip has been prepared. Printing head will locate the appropriate progress strip by means of punch-coded information along one edge of the strip, Col. Fisher says.

Flight plans will be filed from airline or military operations offices by teletype or manually converted from voice into a form suitable for the traffic control computer (located in each Air Route Traffic Control Center) using the Fliden equipment developed by CAA's Technical Development Center.

Each flight plan will be stored in computer's magnetic memory and will also be used by computer to calculate each airplane's estimated time of arrival over each fix along its projected route. With such information, computer can then search for other stored flight plans over the same route, compare their fix ETAs with the new entry to determine if there is a potential conflict. If there is no conflict, flight strips will be printed, as required, for each leg of the flight and distributed by

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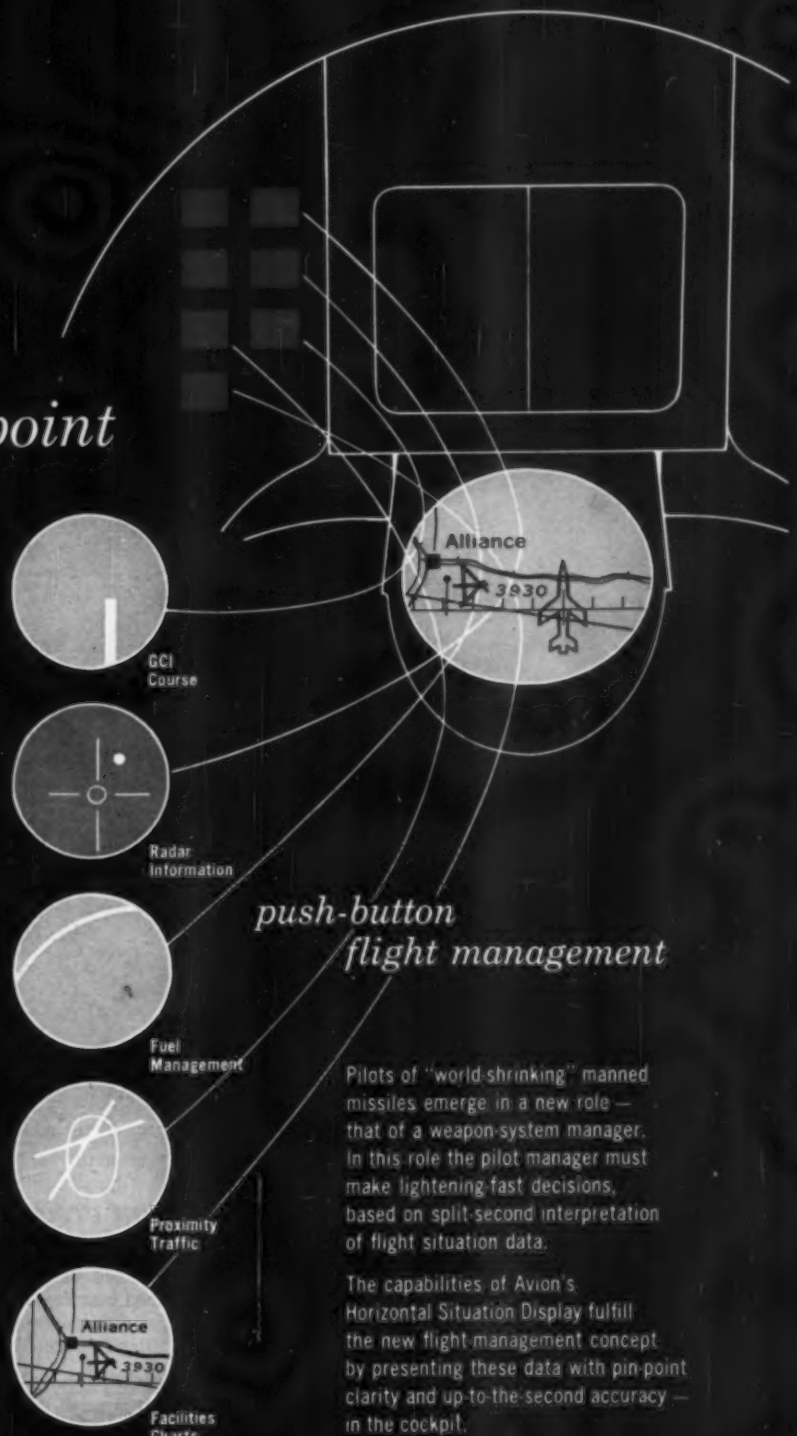
operation pin-point



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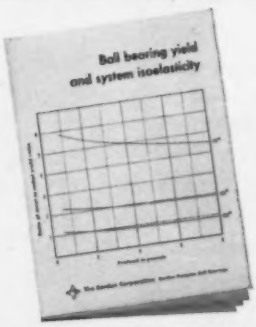

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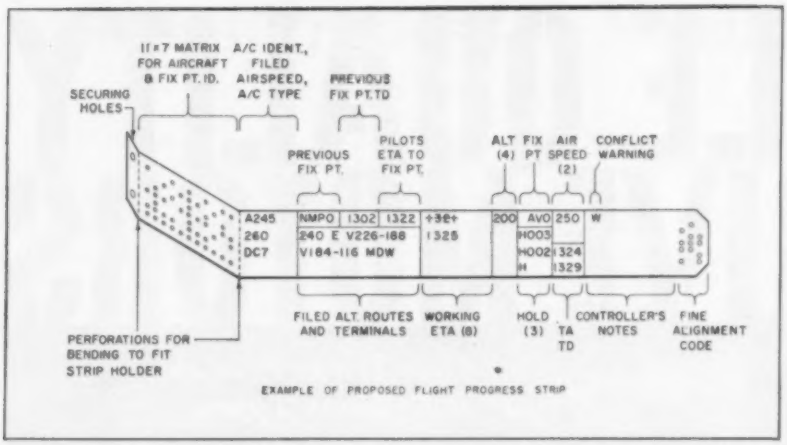
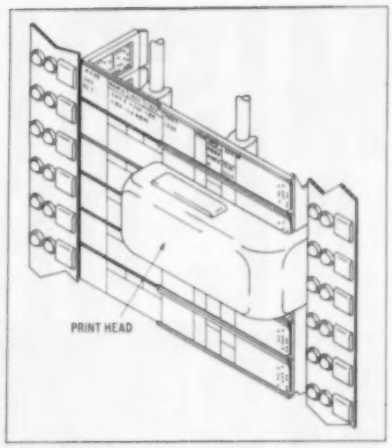




FLIGHT progress strips will be printed out automatically, giving fix ETAs calculated by traffic and control computer. Perforations along strip edge provide identification means for print head (right) which automatically types in revised ETAs on appropriate flight strip. Red warning light alerts controller when airplane has potential conflict; amber light shows when flight strip has been revised. Push button shows airplane on conflict display.

pneumatic tube to appropriate controller who will manually insert it in posting board on his console.

If, however, computer detects a potential conflict between new entry and other flight plans, it will flash a red light on controller's console alongside the flight strip(s) of other aircraft involved in the conflict.

To examine situation in greater detail, controller can push a button and obtain a pictorial display on a cathode ray tube which shows other aircraft in the area of interest at the altitude of conflict.

By pushing another button, controller can ask the computer to search for alternate altitudes and/or times which would eliminate the conflict. However, decision on how to resolve the problem is made by the human controller.

If an en route aircraft asks for a new altitude assignment, controller enters the request into the computer by means of a data entry keyboard. Computer scans its stored flight plans, automatically flashes a red warning light opposite flight strips of any other aircraft which are in conflict with proposed new altitude assignment.

If an airplane fails to make good its ETA over a particular fix, traffic controller uses the data entry keyboard to inform the computer of this fact and enable it to make the necessary changes in its stored flight plan. If any potential conflict arises because of the new ETA, warning lights alert the controller as previously described.

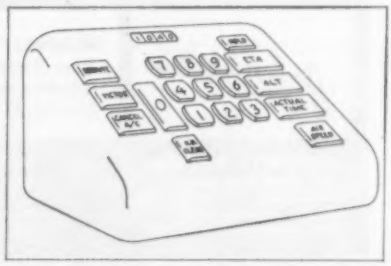
Assuming no conflict, computer causes the printing head at the controller's console to move into correct position opposite appropriate flight strip. Printer then X's-out old ETA, types in the new one on flight strip. There is space for up to six revisions. Orange indicating lamp comes on opposite the revised flight strip to alert the controller of the change.

One of the advantages of the General Precision Laboratory system is that an avionic failure does not knock out the complete system. Controller merely returns to old procedure of writing in revisions by hand and using mental computation.

Initial equipment probably will provide controller with two cathode ray tube displays. One will show present position of all aircraft under controller's jurisdiction, their identity and altitude by means of alpha-numeric coding. Aircraft position display will be based on computer-calculated estimates of position using up-dated flight plan information plus radar data, where available.

The other display will be used to resolve potential conflicts. On it the controller, at his discretion, can display location of all aircraft at any selected altitude in the vicinity of any selected fix, including those of an adjoining sector.

A small circle surrounding the computer-calculated estimate of airplane position will indicate to controller the possible accumulated error in dead-reckoned position since the last report.



CONTROLLER'S data entry handset is used to enter information in traffic control computer, revised flight plans.

Present philosophy is to use en route radar data as a secondary rather than primary information source, to enable system to continue to function should radar failure occur.

Frequent updating of flight plans with actual performance provides computer with a rather complete picture of winds aloft, particularly over high density airways. Computer will store information on winds for eight altitude stratas, use it to automatically modify newly filed flight plans based on outdated meteorological forecasts.

Another interesting possibility, Col. Fisher suggests, is to use computer calculated wind data over heavily travelled routes to update Weather Bureau data and make it available to pilots for their flight plan estimates.

Traffic control computers also will periodically scan their store of flights, make reports to terminal area controllers giving forecast of incoming traffic for the next several hours. This will enable terminal controllers to better schedule traffic flow, anticipate and smooth out peaks to cut delay.

Present timetable calls for prototype General Precision Laboratory system to be ready for experimental evaluation in New York area beginning early in 1959. During the subsequent 18 months, AMB and GPL engineers will evaluate, modify, experiment, modify, and evaluate. Both real aircraft and a traffic simulator will be used in initial tests. (Simulator is being developed by Aircraft Armaments Inc.)

As soon as system is ready, it will be put into operational use in New York area, sector by sector to ease the transition. Present plans are to install terminal area computers and equipments at N. Y. International, Suffolk County Airport (Air Defense Command base), and White Plains (N. Y.) airport.

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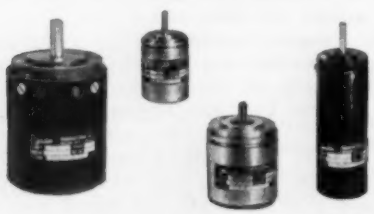
10	115	400	1	11,000	None (Shaded Pole)	.085	7.5	.096 oz. in. at 7000 rpm	3.5 Oz.	....	10-A 8101-01
11	115	400	1	12,000 Synch	0.1	.070	8.0	.08 oz. in. at 12,000 rpm	4.0 Oz.	....	11-A 8110-01
11	115	300–1800	1	10,000 (400 CPS)	0.5 (In Parallel)	.060 (400 CPS)	8.0 (400 CPS)	0.10 oz. in. at 9000 rpm (400 CPS)	5.0 Oz.	....	11-A 8223-01
11	115	400	1	60 Synch	0.1	.070	8.0	12 oz. in. at 60 rpm	7.75 Oz.	200:1	11-R 9003-02
11	26	400	1	30 Synch	2.0	0.35	8.0	14.5 oz. in. at 30 rpm	5.5 Oz.	195:1	11-R 9052-01
15	115	400	1	6,000 Synch	0.3	0.138	15.6	0.14 oz. in. at 6,000 rpm	8 Oz.	....	15-A 8120-01
18	115	400	1	12,000 Synch	0.35	0.148	14.7	0.41 oz. in. at 12,000 rpm	8 Oz.	....	18-A 8125-01
18	115	400	1	7600	0.6	0.45	4.5	2.45 oz. in. at 6800 rpm	24 Oz.	....	18-A 8126-01
18	115	60	1	8.5	1.0	0.175	17.5	30 oz. in. at 8 rpm	20 Oz.	405:1	18-R 9301-01
18	115	60	1	6.0	1.0	0.177	17.8	40 oz. in. at 5.75 rpm	20 Oz.	565:1	18-R 9302-02
21	115	400	1	22,000	1.0	0.75	80.0	1 oz. in. at 20,000 rpm	18.5 Oz.	....	21-A 8142-01
24	115	400	1	11,800	1.5	0.85	130.0	6.17 oz. in. at 10,800 rpm	29 Oz.	....	24-A 8161-01
24	115	60	1	20,000	None Required	1.2	175	8.9 oz. in. at 7,500 rpm	28 Oz.	....	24-U 8826-02
24	115	400	1	78	4.0	1.65	175	1530 oz. in. at 72 rpm	3 Lbs.	1528:1	24-R 9452-02
34	115	60	1	14,000	None Required	1.5	125	15 oz. in. at 4500 rpm	3-3/4 Lbs.	....	34-U 8901-02
34	115	60	1	1,780	3.75	0.45	50	12 oz. in. at 1700 rpm	4-3/4 Lbs.	....	34-A 8044-01



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Avionics Primes for Missile Defense

By James A. Fusca

In 1958 the avionics industry is being challenged to help solve what has been called "the most difficult problem of all time"—defense of the U.S. against intercontinental and intermediate range ballistic missiles.

For this job, the industry will receive contracts that may exceed $2 billion dollars within the next three to five years. Total cost of the three programs presently scheduled—Arctic Warning Line, Nike-Zeus, and Plato—cannot be officially confirmed, but may be expected to run between $7 and $10 billion when completed.

Present plans of the Department of Defense call for:

• **Arctic Warning Line.** Three long range radar sites for early detection and tracking of ICBMs fired against the U.S. will be built in the far North; one in Alaska, one in Greenland, and the third in another foreign territory. Prime contractor for the project is the Radio Corp. of America. Contract will be supervised by the Air Force.

• **Nike-Zeus.** Last month the Department of Defense chose Army's Nike-Zeus anti-missile missile system over the competing Air Force Wizard system and assigned both the Arctic Warning Line and Nike-Zeus systems to the new Advanced Research Projects Agency, under director Roy W. Johnson. Nike-Zeus is to provide missile defense for bomber bases of the Strategic Air Command and—when ready—its ICBM launching sites. System is a development of Bell Telephone Laboratories and Douglas Aircraft Co.

• **Plato.** Designed for use overseas to defend critical installations and personnel in a combat area, Plato is a relatively mobile anti-IRBM system for field army defense overseas under development for the Army by Sylvania Electric Products. Plato system uses the Nike-Zeus missile. Sylvania's contract with Redstone Arsenal is renewable annually, was renewed last December.

Trends for 1958

Aiding the design of effective missile defense systems, as well as avionic equipment for improved missiles, manned aircraft, and ground support systems, have been new techniques and concepts developed in part or in whole during the past year. Trends indicated for avionics during the coming year are:

• **Masers.** Solid state devices such as the Maser and similar microwave amplifiers have aroused much interest and several major companies are said to be actively exploring their use both for ballistic missile detection and extending range of existing radars.

Sperry Gyroscope Co. has named a Harvard Maser expert, Dr. C. L. Hogan, to consulting staff of its Microwave Electronics Division, predicts that "we are on the verge of an important breakthrough that may double effectiveness of anti-missile radars and other detection devices." Hughes Aircraft Co., Radio Corp of America and General Electric Co. are said to be pushing Maser development for similar applications. Navy BuAer Avionics Division is seeking radar or other equipment utilizing Masers for purposes of evaluation.

• **Reliability.** Importance of reliability in avionic equipments is steadily increasing and methods for guaranteeing equipment performance are still being sought. Problem continues to grow as one-shot weapons such as missiles became increasingly more complex and expensive, as ambient temperatures go up and package size goes down. Military services are increasingly placing responsibility for reliability on manufacturers, insisting upon improved basic design and more environmental testing, with the cost of reliability being added to the contract.

• **High temperatures.** With the introduction of more and better high temperature components and increased stringency of environmental specifications, new types of avionic equipment and new areas of operation will be introduced, enabling both manned aircraft and missiles to reduce the heavy premium in space and weight presently paid for cooling devices.

• **Microminiaturization.** Another direction in which component development is progressing is toward microminiaturization. Small volume capacitors, resistors, inductors and other highly subminiaturized components are in production but much development is required to extend ranges of operation and improve their capability for rapid, automatic assembly in modular forms

1957 Developments

One of the major avionic developments revealed in 1957 was the Columbia University ORDIR (Omnirange Digital Radar) technique for extending radar range to 3,000 mi. Developed under an Air Force contract, the Columbia technique was the first public disclosure of a broad USAF research and development program which was based on "fine structure analysis" of radar echoes.

Other contractors working in this field include Lincoln Laboratory, Melpar, Sylvania Electric, Sperry Gyroscope, and Westinghouse. Fine structure analysis is a method of frequency and phase analysis of a radar return signal that permits measurement of target range and velocity with unprecedented accuracy despite signal strengths far below the noise level of the receiver before processing.

ORDIR utilizes frequency modulation of the transmitted signal and sustained coherence of the received signal to permit integration and analysis of the target echo.

The receiver uses a sustained coherence technique to provide signal integration over periods up to 0.5 sec. after which it performs a spectral analysis of the signal to determine range and velocity of the target. Carrier modulation provides range data and Doppler resolution velocity data (AW Aug. 19, p. 28).

Turkish Radar

Another radar development of the past year was disclosure that the U.S. had been tracking missiles being fired from the Soviet base at Krasnyy Yar with a long range radar station located at Samsun, Turkey (AW Oct. 21, p. 26).

Called the AN/FPS-17, the radar has a peak power of two megawatts and a pulse length of 1,000 microseconds. Turkish radar and a second AN/FPS-17 located in Laredo, Tex., where it tracks missiles fired at White Sands, were built by General Electric.

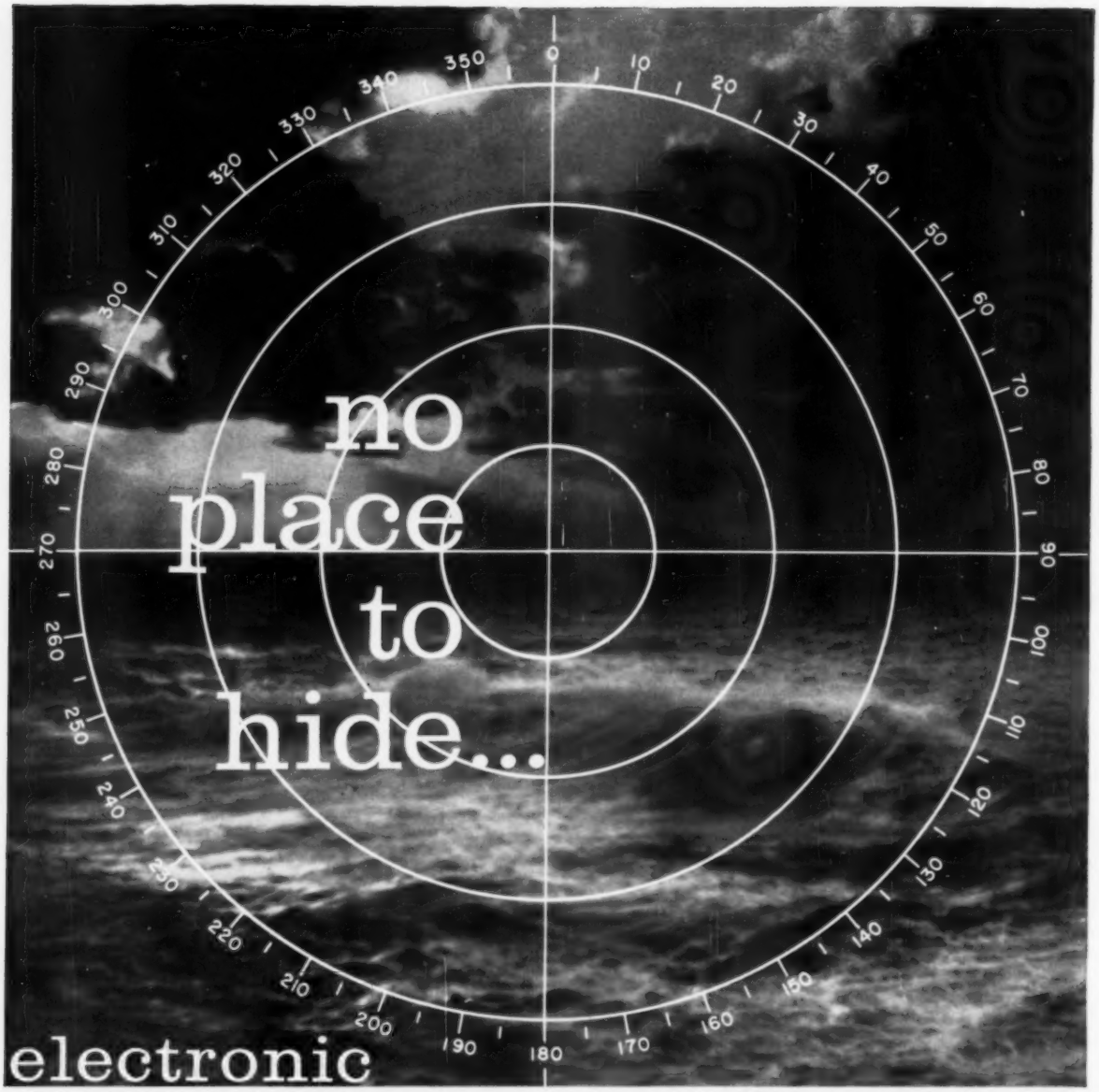
Receiver uses a simple form of coherent detection developed by W. M. Siebert of Massachusetts Institute of Technology's Lincoln Laboratory.

Technique employs modified comb filter sets, crystal filters with narrow passbands and sharp cutoffs. Passbands are adjacent rather than separated by harmonically related stopbands as in conventional comb filters.

AN/FPS-17 has a range of approximately 1,000 mi., uses vertically swept horizontal fan antenna pattern.

Both stations will be modified to use the Columbia ORDIR technique, probably some time during the coming year.

The three long range radar stations to be built by the Air Force as its part of continental defense of the U.S. against ICBM attack will each be



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equipped with two different types of radar sets.

Long range surveillance radar at each site is an outgrowth of the AN/FPS-17. Second type of radar is similar to tracking radar developed by MIT's Lincoln Laboratory, now operational at Millstone Hill about 30 mi. north of Boston.

Millstone radar employs an 84 ft. parabolic reflector which can provide complete hemispherical coverage. Reflector is painted white to reduce effects of heating by sunlight, is mounted on a 90 ft. tower. Range of 3,000 mi. has been obtained against Soviet Sputniks, made possible by specially designed klystrons measuring 11 ft. high that are capable of very large output powers.

Radar returns are processed on a real time basis at extremely high speeds by a special transistorized computer designed and built by Lincoln Laboratory, determining target bearing, elevation, range and speed (Doppler frequency). Data is read out automatically on a high speed printer (AW Nov. 25, p. 34).

Display with maximum range of 4,000 mi. has been developed for the Millstone Hill radar by Allen B. Du Mont Laboratories, Inc., under an Air Force subcontract. Display is conventional B-type scan, presenting 350 deg. azimuth coverage on 16 in. cathode ray tube (AW Jan. 13, p 82).

System Operation

Surveillance radar at each site will continuously scan an assigned sector to detect a Soviet ICBM as early as possible. Rough position data on the intruder will be fed to the Millstone Hill type of tracking radar which, because of its narrow beam width of about four degrees, needs to be aimed approximately in the correct direction.

Millstone Hill radar will track with incoming missile long enough to compute points of launch and impact which will be fed to Air Defense Command at Colorado Springs, Colo., where point of impact data will be used in assigning elements of Nike-Zeus missile defense system while point of launch data is fed to ICBM launching sites for counter-battery fire.

Until U.S. has operational ICBMs for counterfire, about 1964, the 15-minute warning time provided by the Arctic Warning Line will be used to get SAC bombers off the ground for retaliatory strikes. Warning time will also enable population in the impact area to seek protection of shelters.

Nike-Zeus system uses three radars for surveillance, acquisition and tracking. Surveillance radar has range of about 1,000 mi., uses a large Luneberg lens with a mechanical feed system. Surveillance radar will continuously

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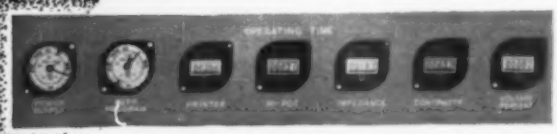

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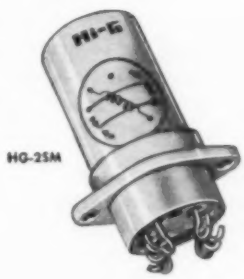

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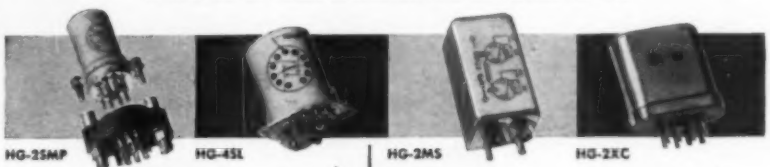

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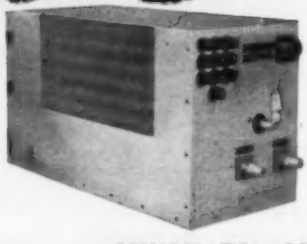

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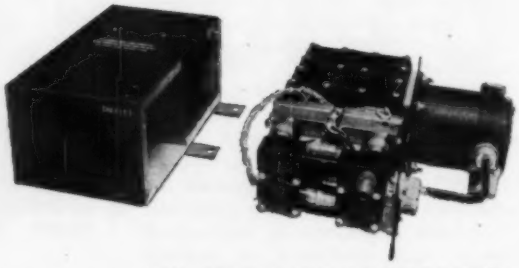

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search area of approach after alert, will upon detection of a target assign one of its acquisition radars to track the missile and compute its trajectory.

Acquisition radar has a range of about 600 mi., uses a similar lens but employs electronic steering. After determining trajectory of an incoming missile, it will assign one of its tracking radars. Each Nike-Zeus battery will have a tracking radar which will be a monopulse system similar to present day Nike tracking sets.

Surveillance and tracking radars use a system of coherent detection developed by Sidney Darlington of Bell Telephone Laboratory. Informed sources have said the system can not distinguish between warheads and decoys. (AW Jan. 27, p. 26).

Decoy Technique

Soviet scientists reportedly have been studying a technique to assist their ICBMs to penetrate U.S. missile defenses by confusing defending radars and computers with large numbers of decoy warheads.

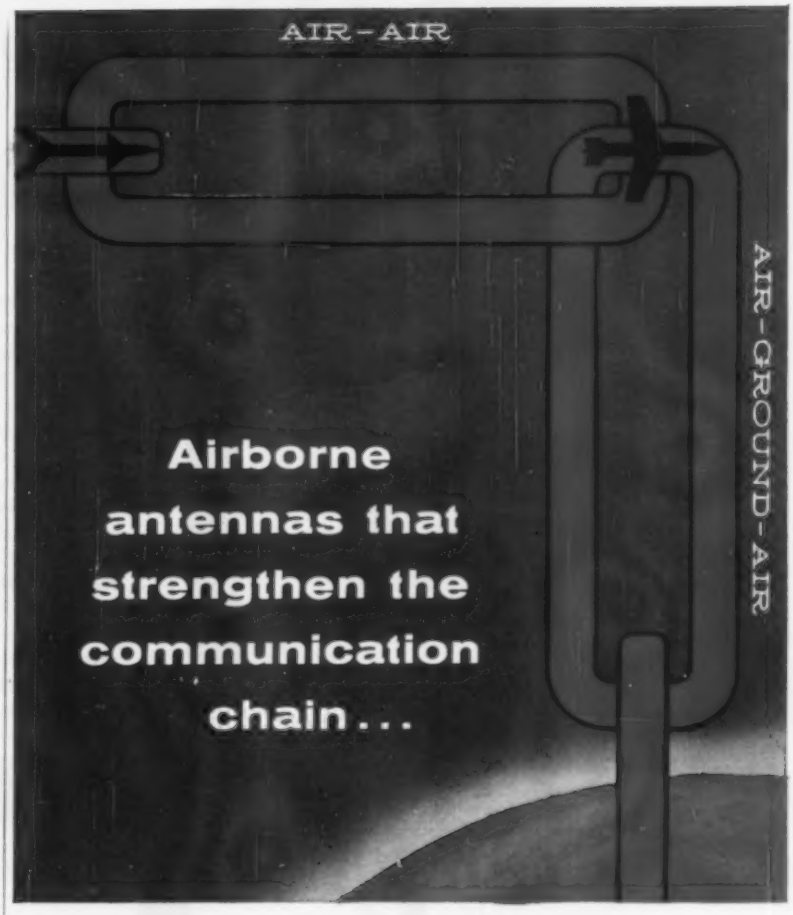
The technique consists of separating the missile's final stage rocket from the warhead somewhere before apogee and blasting the rocket casing, fuel tanks and motor into fragments with a high explosive charge. Fragments will disperse for miles on all sides of the warhead, with many of the fragments making better targets than the warhead.

At extreme altitudes where the final rocket stage would be fragmented, the very thin upper atmosphere would not slow the decoy fragments appreciably. They would maintain about the same relative velocity as the warhead until slowed by re-entry into the heavier atmosphere about 25 mi. from the target. Decoys would be distributed over an area of several thousand square miles extending both in front and behind the warhead.

There are three techniques by which such decoys could be countered. One method is to wait until re-entry, where the decoys will be slowed by the heavier atmosphere because of their relatively smaller mass compared to the warhead. Problem of this method is that it is necessary to wait until the target within 25 mi. of its destination.

If missile can be tracked prior to fragmentation of the final stage, target following the originally computed trajectory can be presumed to be the warhead. This technique, however, requires very early tracking of the missile.

Third method is by means of target analysis. A number of companies in this country working on fine structure analysis techniques believe they can obtain information on target velocity, scintillation, deceleration, etc. which can be used to discriminate between decoys and warheads.



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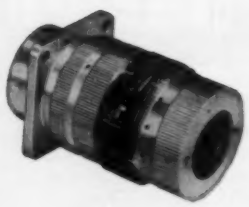

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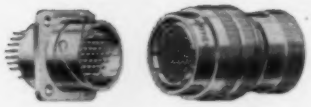
First True Miniature "E"

MINNIE'S are the first miniature connectors to meet fully the "E" performance requirements of MIL-C-5015C. Available as 4 shell types in 4 constructions in 5 shell sizes, ***MINNIE'S*** have a test voltage rating of 1500 volts RMS when sealed with no derating at elevated altitudes. Operating temperature limits are −67°F. to +257°F.

MINNIE connectors have spring-loaded coupling rings to provide a positive locking action and a constant compensating force against the effects of any possible face seal compression "set." 5 stainless steel bayonet pins and slots are used. A unitized rear grommet and cable clamp individually seals and protects each wire lead. The face seal gasket has individual isolating contact barriers.



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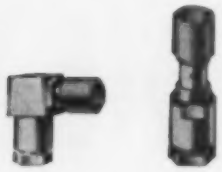
AMPHENOL

MINNIE

4 NEW

AMPHENOL



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SUB*Minax*® field serviceable

No Special Tools for Assembly!

Field serviceable Subminax connectors, for use with RG-196/U Teflon cable, represent a new concept in subminiature RF components. With all parts kept to an absolute minimum, these new connectors *require no special assembly tools.* By simple wrench-tightening, the improved cable clamp firmly grips the smooth Teflon cable, providing maximum cable retention strength. Two Teflon insulators hold the center contact securely in place, preventing possible axial float. Voltage rating is 500 volts peak.

50 ohm plugs, jacks, bulkhead jacks and right angle plugs are available in screw-on and push-on couplings; they mate with the 50 ohm types in the standard Subminax line.

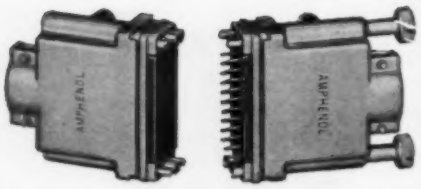
1958 IRE

AMPHENOL ELECTRONICS CORPORATION • CHICAGO 50, ILLINOIS

Circle Number 88 on Reader-Service Card

5 NEW

AMPHENOL



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93 SERIES

Rack & Panel, Poke Home Contacts

AMPHENOL's complete line of 93 Series Rack & Panel connectors is being supplied for use in a production missile. With 8 varieties of housing available for each of 3 insert arrangements, 93 Series connectors offer unusual application versatility—versatility which is increased by the removable Poke Home contacts. Wire termination is accomplished by crimping.

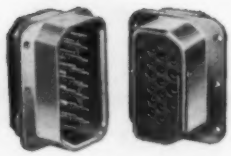
Voltage rating is 500 volts D.C. at sea level; contacts are size 20 and have a current rating of 7½ amps. Resilient fact seal gaskets are employed on both male and female inserts to prevent circuit interruption by moisture, dust, dirt or metallic particles when the connectors are mated. Operating temperature is 400°F., meeting the performance requirement of MIL-C-8384.

6 NEW

Rack & Panel, Poke Home Contacts

94 Series Rack & Panel connectors with Poke Home contacts have polarized impact extruded aluminum shells. A complete line, the 94 Series includes 5 insert configurations in 3 shell sizes; captivated contact coaxial connectors for RG-58/U cable are in 2 inserts. AMPHENOL's unique Poke Home contacts in sizes 16 and 20 assure ease of assembly and allow quick circuit changes.

Voltage rating is 600 volts RMS at sea level. Operating temperature is +257°F. Hooded socket contacts resist test prod damage per MIL-C-5015C; contact solder pockets are recessed in the diallyl phthalate dielectric to exclude the need of additional wire covering after contact assembly.



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AMPHENOL

94 SERIES

IRE 1958

COLISEUM • 2nd Floor • Booths 2321-2327

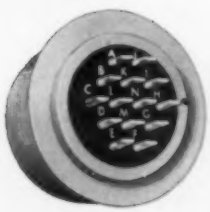
Circle Number 89 on Reader-Service Card

Contact Letters on Glass!

AMPHENOL production engineers have achieved a remarkable *first*. Hermetically sealed MS-type receptacles with *contact identification on the glass insert* are now available—and available only from AMPHENOL. White lettering is provided on both the front and back of the brown glass insert—all letters are sharply cut and legible.

AMPHENOL's *Idento*seals thus combine the advantages of a single *compression-sealed* glass insert with quick and easy identification of each contact—they are labor-saving to use, both in initial assembly and in circuit checkouts.

*Idento*seals mate with standard MS plugs with female inserts. They are available with round or square flange, or in a flangeless shell.



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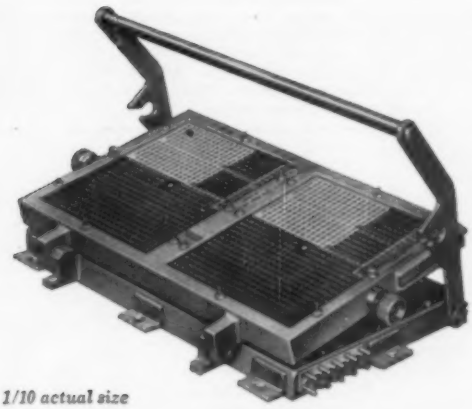
AMPHENOL

Idento SEALS

AMPHENOL



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CUSTOM ENGINEERING

AMPHENOL Custom Engineering adapts standard components or designs new components to special performance and application requirements. By working closely with customer engineering personnel, AMPHENOL can tailor electrical and mechanical characteristics of a new design to an exact application, with resulting tailor-made reliability.

The 1280 contact Programming Board illustrated is an impressive example of AMPHENOL Custom Engineering. The performance requirements in resistance to both shock and vibration were so stringent that no conventional programming board could be used. Example: This Programming Board withstands a shock of 30 G's applied three times along three perpendicular axes. Its outstanding design is typical of the results to be expected from AMPHENOL Custom Engineering.

1958 IRE

AMPHENOL ELECTRONICS CORPORATION • CHICAGO 50, ILLINOIS

Circle Number 90 on Reader-Service Card

TURBO BRAND ELECTRICAL AND ELECTRONIC WIRE AND CABLE

HOOK-UP WIRE

Three types of general purpose, vinyl insulation hook-up wire are listed in each of the two military specifications currently in use. MIL-W-76A, which has superseded JAN-C-76, covers wires rated for 80°C operation (90°C when nylon jacketed); MIL-W-16878B covers wires rated for 100°C operation (110°C when nylon jacketed). Both specifications provide for braids, shields, jackets or any combination of these. The NAS-702 specification is an industry standard requiring nylon coverings, either extruded or braided, and provides for the optional use of shields.

SPECIFICATION	TYPE OR CLASS	SIZE RANGE	VOLTAGE RATING	TEMP. RATING, °C	OUTER COVERINGS[1]
MIL-W-76A	LW	#30 to #20	300	80[2]	Opt-R, G, L, N
	MW	#24 to #12	1000	80[2]	Opt-R, G, L, N
	HW	#22 to #16	2500	80[2]	Opt-R, G, L, N
	HW	#14 to # 6	600	80[2]	Opt-R, G, L, N
MIL-W-16878B	B	#32 to #16	600	100[2]	Opt-R, G, L, N, J
	C	#24 to #14	1000	100[2]	Opt-R, G, L, N, J
	D	#24 to # 6	3000	100[2]	Opt-R, G, L, N, J
NAS-702	A	#26 to # 8	1000	105	Req-N or L
	B	#26 to # 8	2500	105	Req-N or L
	C	#26 to #16	600	105	Req-N

AIRFRAME WIRE

Both polyvinyl chloride and silicone rubber are used as primary insulation in airframe wires. Vinyls are used in Navy BuAer's MIL-W-5086A, a 105°C wire, and in the Air Force's MIL-W-5274A, a 60°C wire. The Air Force's 150°C wire, MIL-W-8777A, has a highly specialized construction requiring silicone rubber insulation and double textile overbraid. The well-known "sandwich" construction, a glass braid between two vinyl layers, is called out by Type III of MIL-W-5086A and Type II of MIL-W-5274A. These wires are available with shields meeting MIL-C-7078A.

SPECIFICATION	TYPE OR CLASS	SIZE RANGE	VOLTAGE RATING	TEMP. RATING, °C	OUTER COVERINGS[1]
MIL-W-5086A	I	#22 to #12	600	105	Req-N
	II	#22 to #12	600	105	Req-G and N
	II	#10 to #4/0	600	105	Req-G and L
	III	#22 to #12	600	105	Req-G, J, and N
	III	#10 to #4/0	600	105	Req-G, J, and L
MIL-W-5274A	I	#22 to #12	600	60	Req-N
	II	#22 to #12	600	60	Req-G, J, and N
MIL-W-8777A	MT	#22 to #12	600	150	Req-G (double braid)
MIL-C-7078A	I	#22 to #4/0	600	*	—
	II	#22 to #4/0	600	*	Req-N (over shield)

*MIL-C-7078A covers shielded one-to seven-conductor cables. Individual conductors meet MIL-W-5086A or MIL-W-5274A.

[1] *Opt-optional, Req-required, G-glass braid, J-vinyl jacket, L-nylon braid, N-nylon jacket, R-rayon braid.*
[2] *10°C higher when covered with a nylon jacket.*

COAXIAL CABLE

In addition to supplying cables to both JAN-C-17A and MIL-C-17B, William Brand has designed coaxial cables with specified electrical characteristics to perform under stated environmental conditions. Cables can be manufactured with single or parallel inner conductors; where the inner conductor is bare, tinned, or silver-plated; of copper, copper-covered steel or resistance wire. Virgin polyethylene is used in the solid or air-spaced cores. Single or double shields are braided from bare, tinned or silver-plated copper. Where non-standard cables are necessary to attain performance requirements, the William Brand Engineering Department will draw on their accumulated experience to recommend the most economical and functional cable.

MULTICONDUCTOR CABLES

The various wires listed above can be assembled in any combination of numbers, sizes and types to form flat or round multiconductor cables. Most designs specify twisted, rather than parallel conductors, because round cables in addition to being more flexible, permit a better control of electrical properties through positioning or grouping of the individual components.

Flat or Parallel Conductors. Three types are available:

(1) 300 Ohm or Rip-Cord Type — Individual conductors are covered simultaneously with a common single-color insulation. Polarity identification is achieved through a contrasting colored stripe or a ridge along one edge, or by using both tinned and bare copper conductors in the cable.

(2) Jacketed Type — Conductors are individually insulated and color coded. Vinyl jackets are so applied that they may be stripped without damage to the underlying conductor insulation. Shielded wires may be incorporated in this type of cable.

(3) Turbo Ribbon Cable® — Individually insulated wires, color coded, are bonded together with excellent adhesion yet rip-cord qualities. There is no outer jacket. Where the individual conductors are nylon jacketed, shielded wires (with overall nylon jackets) can be incorporated. Turbo Ribbon Cable is especially useful where limited space exists. It can be bent along a small radius and will follow the contour of any surface.

Twisted Conductors. Round cables are formed on two types of equipment:

(1) Bunchers — The several wires are twisted together in random arrangement; the individual components do not necessarily lie in a fixed pattern. The bunchers at William Brand & Co. can twist any number of conductors with a maximum cabled diameter of ½".

(2) Planetary Cablers — The most versatile type of cabling equipment. Any number of shielded, overbraided or vinyl covered singles, pairs, cabled groups or combinations of these can be helically laid in a predetermined sequence. Concentric layers can be applied over a single wire or a cabled core, with the direction of lay of each layer varied at will.

Both types of round cable can incorporate textile or plastic fillers to produce finished cable with circular cross section. Binders, wraps, tapes, shields or textile braids can be applied over each layer as required. Outer coverings can be of extruded plastic or braided textile yarns.

The William Brand engineering staff has had extensive experience in the multiconductor cable field. Their collective knowledge is at your disposal. Turbo Engineers will assist you in developing a suitable cable, or given electrical and physical requirements, will design a functional and economical product.

We invite you to make full use of our services in the solution of any wire and cable problem.

TURBO BRAND ELECTRICAL INSULATING TUBING

TUBING

Two general classes are manufactured by William Brand & Co. — extruded polyvinyl chloride, and textile braids impregnated and coated with insulating varnish. The plastic tubings fall into three categories — general purpose, and high and low temperature types. The coated tubings also fall into three temperature classes: A, B, and H, each with its specific operating temperature limit. All tubings are available in sizes #24 to 2½" I.D. and in all MIL-STD-104 colors. Plastic tubings can also be furnished in transparent. Generally speaking, plastic tubings are supplied in continuous lengths on spools or coils; coated tubing is furnished in 36" or 42" lengths.

PLASTIC TUBING

SPECIFICATION	TYPE	TEMP. RANGE	BRAND DESIGNATION
MIL-I-631C	Grade c, Class II, Category 1 and 2	−10° to +105°C	Turbotrans 105
MIL-I-631C	Grade b, Class II, Category 1 and 2	−46° to + 60°C	Turbolex 55
MIL-I-631C	Grade a, Class I and II, Category 1 and 2	−30° to + 80°C	Turbolex 76
MIL-I-7444A(2)	Range I, II and III	−68° to + 80°C	Turbozone 40

COATED TUBING

SPECIFICATION	TYPE	COMPOSITION		TEMP. RANGE	BRAND DESIGNATION
		BRAID	COATING		
MIL-I-3190A	A-A-1, A-B-1, A-C-1	Cotton or Rayon	Organic Varnish	−10° to −105°C	Turbo Varnished Tubing
MIL-I-3190A	B-A-1, B-B-1, B-C-1	Glass	Organic Varnish	−10° to +130°C	Turboglas Varnished Tubing
MIL-I-3190A	B-A-1, B-B-1, B-C-1	Glass	Vinyl Varnish	−10° to +130°C	Turbotuf Tubing
MIL-I-3190A	H-A-1, H-B-1, H-C-1	Glass	Silicone Varnish	−10° to +200°C	Turbosil Tubing
MIL-I-3190A	H-A-1, H-B-1, H-C-1*	Glass	Silicone Rubber	−75° to +200°C	Turbo 117 Tubing

*Silicone rubber coated tubing not covered by specification. Turbo 117 will meet all performance requirements of MIL-I-3190A.

WILLIAM BRAND & CO. INCORPORATED TURBO BRAND WILLIMANTIC 4, CONNECTICUT

Circle Number 91 on Reader-Service Card

Helicopters....

Vertol 44 on Offshore Oil Rig

Checking the lead of the internal gear used in the second stage of the Sikorsky S-58 Helicopter. Permissible lead error is only .0003 in. of face. This gear is finish cut at 50 Rockwell C. It's actually much harder than a good penknife blade.

Precision is our only product!

• The aeronautical age has given the word precision new scope. Tolerances have shrunk farther past the decimal point. Stresses and strengths have new dimensions. Yet, whatever the specifications are, I.G.W. still has just one product—precision.

IGW

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BELL HU-1

● HELICOPTERS

All-Weather Helicopters Near Reality

New York—Gas turbine powered helicopters with all-weather flying capability moved much closer to reality during 1957 as several companies advanced their turbine models and automatic stabilization and instrumentation projects well into the testing and certification stage. The Army ordered the first turbine powered helicopter into production in the U. S., the Bell H-40.

General reports from manufacturers indicate that test programs with turbine powered experimental models have been more successful than previously predicted. Maintenance-wise, and from the fuel economy aspect, the new engines will soon be competitive with piston engines. Initial costs are still quite high however, but this is expected to be reduced substantially as soon as large scale production begins.

Probably the most sophisticated and advanced helicopter stabilization and automatic control systems are under development for the Navy. The main reason behind this work is to provide a more efficient vehicle for anti-submarine warfare (ASW).

The helicopter has proven a very useful ASW tool, but its effectiveness in searching for submerged submarines has been limited in rough weather. The sonar gear which the helicopter lowers into the water must remain absolutely stationary. The helicopter must maintain altitude precisely and cannot move from side to side or the chang ing pressures on the sonar package will disrupt its readings.

Electronic Stabilization

The Navy has worked through several contractors as well as its own personnel at Johnsville, Pa., to develop electronic stabilization units for helicopters similar to aircraft autopilots. Several different systems have been built and tested. One of the systems, allowing complete hands-off hovering and forward flight, was designed by Sikorsky as an integral part of the Navy's HSS ASW helicopters.

This unit has been service tested for over 60,000 hours in 200 helicopters and even though it is a somewhat complex electro-mechanical device it has had a very satisfactory record, averaging 200 hours use without a complaint of any kind and more than 800 hours without complete malfunction.

Slightly more advanced units incorporating especially developed navigating instruments for slow moving aircraft are now under development by Naval personnel at Johnsville and they will probably be required equipment in the future for ASW helicopters which will carry out prolonged missions in the roughest weather.

Parts of the Sikorsky automatic stabilization equipment are under test by the CAA for civil certification. Other firms are preparing complete blind-flying set-ups for their helicopters. Probably during 1958 it will be possible for commercial operators to safely fly at night and in adverse weather with the aid of these effective stabilization units and instrument flying systems.

All-weather passenger service will follow as soon as twin-engine helicopters are available that can maintain flight on one engine.

Flight Tests

Airways Modernization Board has announced plans to begin tests with Bendix-Decca navigational equipment in scheduled service with New York Airways during April. These units give a pictorial presentation of the aircraft's position and over the short route used by New York the scale will be as large as 850 feet to the inch.

It is hoped that this will enable pilots to navigate with pinpoint accuracy when the visibility is absolute zero or below minimums.

The Army—with an atomic combat doctrine based firmly on mobility and air-transportability—is still struggling to obtain aircraft in the proper numbers and proper categories. Its helicopter program, which is fundamental to the

HILLER XROE-1 ROTORCYCLE

HILLER H-23D

mobility concept, has been pushed in three ways:

• **Helicopter operating costs** are being lowered through accelerated testing programs.

• **Congress and Administration** are being presented at every opportunity with the Army's need for new rotary wing equipment in all categories especially a large crane comparable to Russia's 80 passenger Mi-6 helicopter.

• **Available funds are** being used to develop turbine engines, flying jeeps, turbine powered helicopters, armed helicopters for flying cavalry units and a number of one-man rotary wing aircraft.

Accelerated service testing of helicopters was under way by the Army during all of 1957. Object of these tests is to put new equipment through 1,000 hours of service type flying as quickly as possible. The information obtained is sent immediately to the company manufacturing the new helicopter and necessary design changes are made at once, service life on many parts are raised, and spare parts orders are revised to reduce overbuying.

In the past it has taken as long as five years to put 1,000 hours of service use on helicopter types. The primary result of this was that spares were purchased for several years according to pre-production estimates which often proved to be several hundred percent in error.

Spare Parts

As spare parts costs are the main expense in operating helicopters buying unnecessary spares had a nearly disastrous effect on the Army program. A large number of highly placed Army officers have described large scale military operation of helicopters as too expensive if costs did not come down.

The accelerated test program undertaken by the Army has found agreement among manufacturers as the type of military operation needed to lower costs.

The manufacturers are cooperating in everyway and have high hopes that the tests will put the helicopter in a firm position to meet the competition of VTOL and STOL aircraft that are becoming more and more attractive as new turbine engines become available.

The Army is continually presenting the Congress and Administration with requests for funds to develop more efficient helicopters. At the moment the prime unanswered need is a large flying crane with a lifting capacity of 12 to 16 tons. Such a crane would be equipped with interchangeable pods and carrying rigs to transport personnel, ground vehicles, supplies, wounded, command posts, etc. At present the largest Army helicopter the

Sikorsky H-37A will lift about half as much as the new Russian Mi-6 turbine powered machine which has a payload of 11 tons and better

Development of other new equipment must begin if the Army is to make full use of present technology and remain a fully modern service. Along this line three contracts were let during 1957 for the construction of flying jeeps. It also marked the reentry of the automotive industry into the aircraft business. Chrysler Motors along with Piasecki and Aerophysics was awarded one of the contracts. These jeeps all make use of ducted fans and the Army specifications call for them to lift 1,000 lb. payload, yet weigh only 1,000 lb. with fuel, which is a significant increase in vertical lift performance.

Flying Cavalry

Army needs also include better performing helicopters for the flying cavalry units now under development. These units are heavily armed groups primarily composed of weapons and troop carrier aircraft. The weapons aircraft cover the landing of the troop carriers. The concept is in an advanced state and when money is available operational units will be formed. They are intended to be self-supporting in the field for three days or more without resupply and capable of large scale attacks by quick grouping. They will be able to maintain surveillance over five or six times as much territory as a motorized unit.

One of the Army's major problems is common to all of the services. That is keeping competent personnel. The turn-over among qualified pilots and mechanics is over 70%, lowering the effectiveness of operational units and raising training costs. The situation is further complicated in that the Army aviation service does not have a large backlog of trained officers and when officers are rotated according to Army policy a large number of men are transferred to posts that they are unprepared to assume. When they have reached proficiency it is usually time for them to be moved into another assignment and an untrained officer moved into the aviation branch.

Civil Operations

Civil helicopter operators are anticipating a steady increasing volume of business during the next several years, even better than the success that they have enjoyed in the past. Equipment-wise, the operators' most prominent desires are:

- **All-weather** capability.
- **Better payloads** through economical turbine power.
- **Lower operating** costs.
- **Larger aircraft.**

SIKORSKY HR2S-1

SIKORSKY HSS-1 TESTBED FOR T58

As in the past, military development programs will contribute heavily to the equipment that becomes available on the civil market. Most operators and manufacturers do not anticipate either all-weather capability or economical turbine power for at least two years. Operating costs for aircraft now in use are going down as experience builds up and allowable service life and inspections and overhaul time are increased.

One manufacturer, Sikorsky, is designing a civil helicopter using a turbine engine and the dynamic system from the proven and successful S-55. The new machine, the S-62, is amphibious and will become available commercially just as the cost of turbine engines reaches the piston engine level (Fall of 1959), if Sikorsky's estimates are correct. The company will then have a very attractive sales argument with a 700 lb. greater payload than the piston powered aircraft, dynamic system parts that are widely available and have an average service life of about 1,000 hr.

According to the Aircraft Industries Association one of the biggest stimu-

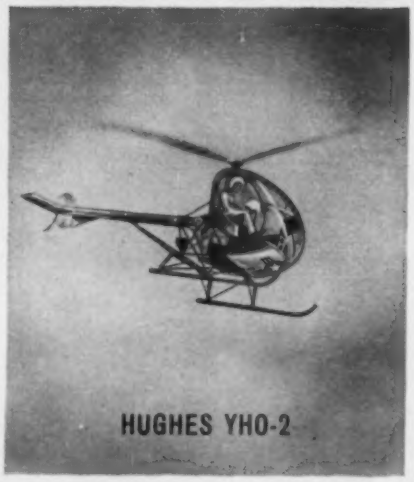
Lycoming

power for today's Army Aviation

BELL HU-1 IROQUOIS

RYAN MODEL 92 VERTIPLANE

BEECH L-23D SEMINOLE



HUGHES YHO-2

AERO COMMANDER L-26C

For further information on Lycoming's complete line of aircraft power plants, write to: Lycoming Division, Avco Manufacturing Corporation, 550 South Main Street, Stratford, Connecticut.

BRANTLY YHO-3

GRUMMAN AO-1 MOHAWK

VERTOL 76 TILTWING

HILLER H-23D RAVEN

BELL H-13H SIOUX

Turbine—or piston-powered, VTOL/STOL, fixed—or rotary-wing . . . whatever the aircraft, whatever the job—there's a dependable LYCOMING engine for it.

1908-1958
FIFTY YEARS
OF POWER

Lycoming

A Division of **Avco** Manufacturing Corporation

Stratford, Conn. Williamsport, Pa.

Rascal JOINS SAC

The nation's first air-to-surface missile, the Bell GAM-63 Rascal, is now on operational status with the Strategic Air Command of the U. S. Air Force.

This rocket-powered guided missile can extend the penetration ability of SAC crews since it is launched and accurately directed on its mission while the bomber which carries it remains many miles away from the target area.

Bell Aircraft designed, developed and now produces the Rascal "Crewsaver" for the Air Force under a complete weapon systems responsibility. This responsibility includes the airframe, guidance, liquid fuel rocket power plant, ground support and launching equipment and techniques and training.

BELL *Aircraft* CORP

BUFFALO, N. Y.

Circle Number 214 on Reader-Service Card

lants to public interest in helicopters was the recent announcement that two single-engine Bells had been purchased for presidential use. This was evidently the kind of assurance that many businessmen needed as to the safety and reliability of helicopter transportation.

Use of helicopters by private corporations is growing steadily and the variety of jobs that they perform is widening, and includes laying telephone lines and setting the poles, transporting complete oil drilling rigs into inaccessible spots, etc. as well as personnel transport.

Passenger Operations

Scheduled passenger helicopter operations also improved during 1957. New York Airways, for instance, flew 68,120 passengers, an improvement of 25,086 over 1956. Chicago Helicopter Airways will set a new record for rapid growth if its present rate of business continues until June.

The line will have carried 100,000 passengers in the first 20 months of its existence. Actually Chicago's business should increase as they have recently expanded their equipment inventory from three Sikorsky S-58s with the addition of two more of the aircraft.

Scheduled passenger service operators are adamant in their demand for larger machines. They want a helicopter with at least a 25-passenger capacity. A small number of such aircraft with turbine power and water landing capability are being designed in this country. The first large turbine powered helicopter of this size that will be available (if the present development rate continues) is the Fairey Rotodyne which is receiving close attention from many U.S. operators.

Until recently Sikorsky held a monopoly on supplying helicopters for scheduled passenger service, but Vertol broke into the field a short time ago with the sale of five H-44 tandem rotor machines to New York Airways. This sale is subject to CAB approval, but it will give NYA 15 passenger aircraft, an increase over the S-55 and S-58 equipment now in use.

Forestry Use

Use of helicopters by civil agencies of the government is also on the rise. The forestry service, in cooperation with the U.S. Army Corps of Engineers, has prepared a number of forest fire fighting kits to be used with several types of helicopters up to the size of the Sikorsky S-55. The kits allow helicopters to lay hose, carry pumping units, spread chemicals and water on a fire, and to drop specially suited firefighters onto all types of terrain from the hover.

Bench-Top Proving Ground for Missile Controls!

Directional controls for guided missiles . . . tracking and scanning devices . . . cameras . . . range finders—how well they work depends greatly on the efficiency of their optical systems.

Recognition Contrast Rendition equipment at B&L completely eliminates human error in measuring optical efficiency. Its direct-reading scale automatically rates how well an optical system can "see" under lighting conditions of variable intensity, as experienced in actual use. Accuracy: 1/40th of a wavelength of light!

This instrument is not for sale. It is part of the unique quality control system that has made Bausch & Lomb the dependable optical source.

WRITE FOR COMPLIMENTARY COPY OF LIMITED EDITION, "OPTICAL COMPETENCE"

(on official letterhead, please, indicating title.) Bausch & Lomb Optical Co., 86927 St. Paul St., Rochester 2, New York.

BAUSCH & LOMB

SINCE B&L 1853

Circle Number 170 on Reader-Service Card

TWA offers LOWEST FARES EVER

year-round* to EUROPE

New! TWA Sky Club Economy Fares aboard the Jetstream!† Fly to Europe and back for $113.40 less than regular round-trip Tourist fares. Save enough for extra fun abroad. It's the biggest bargain in the history of air travel to the Continent! Make your reservations now. Call your TWA travel agent or nearest TWA office today.

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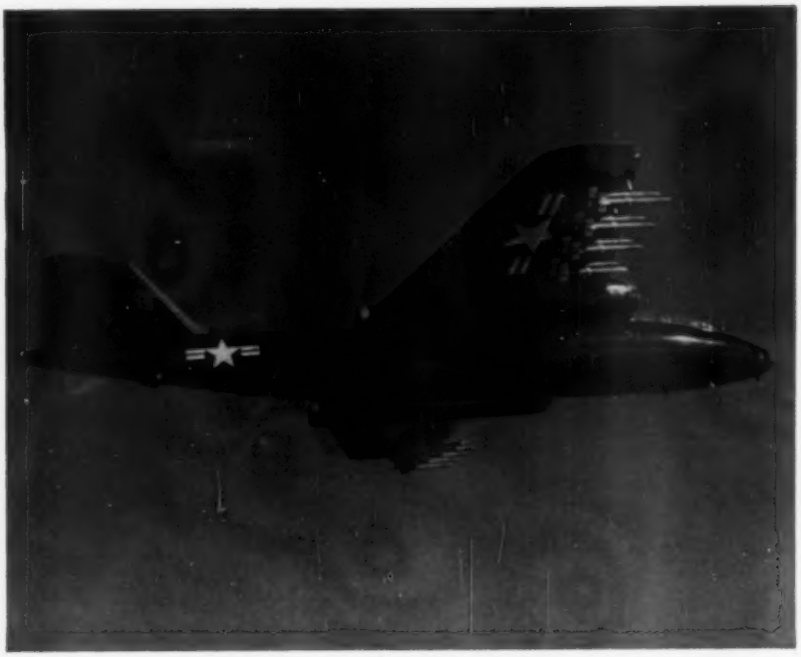
Business Flying....

Beech MS-760 Executive Jet



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LOCKHEED JETSTAR

Business Flying Gains New Markets

By Erwin J. Bulban

Business flying's potential as a major factor in the future U. S. aviation economy broke forth with explosive clarity in 1957. Awareness of this potential paced business flying's progress as it entered 1958 backed by a healthy industry rapidly expanding in depth technically, with its users continuing to outdistance all other segments of general aviation and with the knowledge that it is achieving long-sought recognition of its maturity and requirements from top echelons in government.

Industry serving business flying has grown stronger and broader than anytime in its history—in the past five years it has about doubled its annual production and tripled its dollar volume.

Flying Increases

Operationally, business pilots logged some 5 million hr. last year, approximately 1 million hours more than the combined total of all U. S. scheduled domestic airlines. This was an increase of about 500,000 hr. over 1956, continuing the upward slant that has seen business flyers more than quadrupling the hours they flew just 10 years ago. In the year past they also flew, by conservative estimate, some 800 million plane-miles and 2 billion passenger-miles.

The privately operated air fleet that achieved these marks numbers some 25,000 airplanes; in addition some 10,000 more airplanes did some business flying last year. Breakdown of the fleet shows that there are approximately 3,500 multi-engine airplanes and some 21,500 single-engine types primarily four-place, with most of the latter having been manufactured in the past decade.

Ownership of this fleet is divided among almost 10,000 companies and 10,000 individuals. Estimates by the trade are that this fleet will double in numbers by 1970.

Lucrative market provided by this constant buildup and that promised by forecasts has been prime factor in constant expansion of the business aircraft industry. Last year there were tangible signs that this awareness had penetrated well beyond the boundaries of the original handful of manufacturers who have specialized from the start in supplying this market.

At National Business Aircraft Assn.'s annual meeting and forum at Denver last fall, large numbers of a new breed of suppliers packed the display booths, filled the hotel suites and were represented at forum discussions—manufacturers hitherto primarily or wholly committed to the military and airline markets.

Major reasons for this new interest:

PIPER PA-24 COMANCHE

U. S. Business & Utility Aircraft Shipments—1957

(Number of Units, Builders' Net Billing Prices)

Make & Model	January	February	March	April	May	June	July
AERO DESIGN 560A, E	1	1	0	0	2	7	4
560	18	7	10	15	11	9	9
	$1,416,000	$635,000	$774,000	$1,162,000	$976,000	$1,040,000	$828,000
BEECH 35 Bonanza	41	47	45	52	52	44	49
D18S	0	0	0	0	0	2	4
E18S	11	8	12	13	11	10	7
45 Mentor[2]	0	0	15	10	0	0	0
50 Twin-Bonanza	15	5	6	8	9	13	12
95 Travel Air	0	0	0	0	0	0	0
	$3,048,221	$2,122,378	$3,263,758	$3,315,045	$2,823,000	$3,002,000	$2,947,000
CALL A4	2	2	3	3	4	1	8
	$11,620	$12,270	$19,000	$18,000	$23,000	$8,000	$37,000
CESSNA 170B	6	9	9	11	1	0	0
172	58	66	67	58	70	94	72
180	40	39	50	56	45	31	32
182	81	62	68	102	82	87	90
195[3]	0	0	0	0	0	0	1
310	15	14	13	14	11	3	7
310B	0	0	0	0	0	0	0
L-19[1]							
	$2,557,600	$2,381,868	$2,513,000	$2,881,741	$2,445,000	$2,150,482	$2,323,107
CHAMPION 7EC	13	10	25	16	6	4	5
7FC	0	0	0	14	13	12	12
	$52,745	$47,000	$102,244	$136,000	$99,000	$80,000	$83,000
COLONIAL C-1 Skimmer	3	3	5	1	2	1	2
C-2 Skimmer IV	0	0	0	0	0	0	0
	$56,000	$51,000	$87,500	$17,000	$34,000	$17,000	$34,000
HELIO 391B Courier	2	2	2	2	3	3	3
392							
	$46,000	$46,000	$52,000	$52,000	$73,000	$78,000	$78,000
MOONEY 20	6	5	10	5	7	8	11
	$61,000	$49,000	$99,900	$50,000	$70,000	$80,000	$113,000
PIPER PA-18	26	26	45	33	34	30	11
PA-18-A	40	49	82	49	60	40	29
PA-22 Tri-Pacer	123	90	127	93	117	87	66
PA-23 Apache	48	30	49	34	48	30	26
	$2,541,873	$1,865,744	$2,774,540	$2,031,004	$2,546,558	$1,817,529	$1,422,678
TAYLORCRAFT 20	1	1	1	1	1	1	1
	$10,865	$10,000	$11,000	$11,000	$11,000	$11,000	$11,000
TOTALS (Aircraft)	550	476	615	564	587	517	459
TOTALS (Net Billing Price)	$9,801,932	$7,220,242	$9,696,942	$9,684,390	$9,205,550	$8,282,021	$7,674,785

[1]Fire completely destroyed production facility in late August. First delivery, Commander No. 593, made to Southern Natural Gas Co., made Jan. 29.
[2]Export version of Beech T-34 trainer; since sales not made through U. S. military services, it falls in category of civil transaction.
[3]Out-of-production surplus factory-owned aircraft.

Administration's austerity military budget along with associated on-again off-again programs, trend to fewer, deadlier aircraft capable of greater mission capability than larger numbers of previous types and the revolution toward manned and unmanned space craft. Seeking to diversify to maintain their plant, military manufacturers are turning to the business plane field.

New Entries

Among the top firms actively interested in entering business flying:

• **Grumman Aircraft Engineering Corp.,** whose new twin turboprop-powered Gulfstream, seating 10-20 passengers, is rapidly taking shape at Bethpage, N. Y. Prototype is scheduled to fly in April, deliveries will probably begin next year. Basic airplane starts at $700,000. Grumman says that it has more than a dozen orders for the new Rolls-Royce Dart-powered executive transport, emphasizes that production will not be dependent upon military orders. Grumman also is actively studying the utility aircraft field; having built two agricultural airplane testbeds for market study. As yet this airplane is still a project and the company management has made no decision as to production.

• **Fairchild F.27 Friendship,** built under license from Fokker, seats up to 40 passengers, is primarily aimed as a local airliner. Well over a dozen corporations have Friendships on order, with basic price of $590,000 with Rolls-Royce RDa.6 Darts and $650,000 with RDa. 7s. Deliveries begin in June.

• **Lockheed Jetstar** is a 10-18 seater powered by either two Bristol Orpheus or four Fairchild J83s or GE J85s. Jetstar was primarily designed to Air Materiel Command requirements for a highspeed VIP transport, but Lockheed is taking priority production line positions from civilian customers, quoting a basic price of about $800,000 minus engines. Company has a prototype in flight test, quotes delivery dates as mid-1960. Indications are that Jetstar hinges upon a military contract.

Another sign of how former military and airline contractors are interested in the executive plane market is the considerable technical assistance provided by Allison Division of General Motors to On Mark Engineering Co., on the latter's Model 450 Marksman, a 14-passenger transport designed around two Allison 501-D21s which would give it a cruise speed of 425 mph. Several orders have been placed for the Marksman, which is priced at about $1.18 million.

Equipment Market

Not only are airframe makers seeking entry into this field, but scores of equipment manufacturers: Fairchild's Engine and Stratos Divisions, General Electric, Collins Radio, Aerojet-General and numerous others. Several companies who have been supplying business flying with equipment for several years have strengthened their activities in this field and set up specialized general aviation or business flying departments.

Most of the new turboprop and jet-powered transports are aimed at replacing the numerous World War II surplus bombers and transports that in many

August	September	October	November	December	Totals
7 4 $711,000[1]	4 11 $941,000	1 8 $765,000	2 5 $489,000	0 3 $200,000	29 110 $9,914,000
39 0 13 10 10 0 $3,221,000	38 0 8 0 10 0 $2,358,000	23 0 7 0 6 0 $1,629,000	44 0 5 0 7 3 $2,066,000	41 0 6 4 7 6 $2,315,000	515 6 111 39 108 8 $32,110,402
3 $18,000	4 $26,000	0 0	1 $19,000	2 $14,000	33 $203,830
0 81 23 62 0 5 0 $1,901,000	0 43 27 49 0 0 12 $1,820,000	0 79 30 39 0 0 23 $2,588,000	0 169 18 14 0 0 16 $2,534,000	0 82 53 98 0 0 17 $3,465,000	36 930 438 835 1 82 68 90 $29,470,790
9 14 $122,000	5 15 $104,000	11 11 $106,000	6 8 $80,000	5 8 $70,000	115 107 $1,063,900
1 0 $17,000	0 0 0	0 0 0	0 0 0	0 1 $21,000[2]	18 1 $334,500
3 $78,000	2 $52,000	4 $100,000	3 $82,000	4 $100,000	33 1 $842,000[3]
14 $143,000	14 $145,000	10 $104,000	3 $31,000	14 $148,000	107 $1,083,900
24 42 76 23 $1,453,137	24 28 82 28 $1,536,834	19 34 75 37 $1,871,104	17 36 82 29 $1,746,394	22 29 86 21 $1,825,175	311 488 1,104 401 $23,235,162
1 $11,000	1 $11,000	1 $11,000	1 $11,000	1 $11,000	12 $130,885
464 $7,878,137	405 $6,995,834	418 $7,174,104	371 $7,016,394	509 $7,878,175	6,145 $90,406,506

[1]Liaison aircraft sold to French government; since sale not made through U. S. military service it falls in category of a civil transcation.
[2]List price.
[3]Does not include sale of one custom-modified Strato-Courier for high altitude aerial survey to Mexican-based operator.

cases have been used because there were no substitutes available.

Some observers have questioned the fate of the new generation of airplanes in light of attempted disposal by airlines of surplus piston-engine fleets in preparation for jet transports. Feeling currently is that these will not have a major effect on this field, primarily because high cost of converting primarily short-haul high-density transports to long-haul executive aircraft would not appear to be an attractive business proposition in view of obtaining a modern turbine-powered airplane at not too much a price differential.

Industry Core

Regardless of which way this new equipment fares, backbone of business flying industry for the foreseeable future will continue to be the hard core of the industry of past years, such as Aero Design & Engineering, Beech, Cessna and Piper.

Aiming for the mass business plane market, they have evolved what comprises a whole new family of business planes, providing the prospective buyer with the largest selection ever available.

Business plane manufacturers have done well in two areas: designing a wide variety of economical vehicles and proving the value of these planes in saving executives' and salesmen's priceless time as well as enabling them to spread their sphere of operations more economically than can be done with any other transportation.

Still to be licked is the basic selling job. For the most part, the major portion of sales continues to be to people already owning airplanes. Weakness of this position was spotlighted last year, when following record-breaking calendar 1956 deliveries by the Big Three of 6,348 units, they slid to 5,580 units in 1957. Major portion of this drop was attributed to Cessna, whose deliveries slipped 738 units from 1957 even when counting in delivery of 90 L-19 liaison aircraft to the French government. Slippage brought Cessna's commercial net billings for calendar 1957 down to some $29.4 million compared with the previous similar period of $38.3 million. Piper also slid some last year compared with 1956; though not as sharply: its deliveries in calendar 1957 totaled 2,304 units compared with 2,362 in 1956. Subsequent billings for calendar 1957 showed only a slight decrease: $23.2 million compared with $23.4 in 1956.

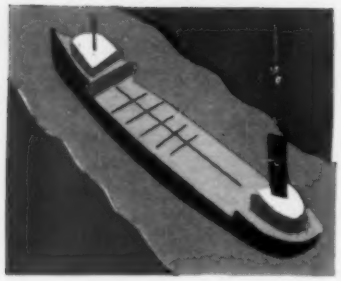
Beech Gain

Beech actually showed a gain both in units—787 last year compared with 759 in 1956—and billings were up to $32.1 million in 1957 compared with $28.7 in 1956.

What caused the slippage last year? Primary reason was overstocking on part of the distributors in 1956, resulting in decrease in orders in 1957 until inventories were worked down. According to one manufacturer, the field sales organizations oversold themselves in 1956, leaving them with a slimmer prospect list the following year.

This pointed up the job the manufacturers still have to do in working out some remaining kinks in their sales techniques—and in increasing their sales to first-time customers. This they are doing: considerable effort is being ex-

CESSNA MODEL 175



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pended on overhauling the sales approach and providing the salesmen with a greater amount of training, more selective hiring of sales personnel and increased promotional backing from the factory. Cessna for example has boosted its promotion budget for 1958 from approximately $350,000 to some $500,000, will put greater effort in certain sales areas, such as Northeast U.S. this year to build volume.

Company has found that such sales "task force" efforts pays off; last year it noted that following concentrated work in the Central and South American field, it reaped a substantial increase in sales in those areas.

Deliveries

Indications are that this year will show marked improvement in unit deliveries and sales over 1957, perhaps even exceeding the record 1956 volume. Lower inventories in the dealers hands last year should mean stepped up demands for increased factory deliveries in 1958.

Also, manufacturers entered this year with the largest model line yet available. Piper began deliveries of its new low-wing four-place Comanche 180, turning 26 over to its dealers in January. It is scheduling buildup in Comanche production to rate of four a day late in 1958. In addition it has new models of its Apache and Tri-Pacer, both fitted with 160-hp. Lycomings.

Beech started deliveries of its new Travel Air light twin in November; has an improved version of the Bonanza with fuel injection engine for 1958 in addition to two improved Twin-Bonanza models and its Super 18. Company will also deliver the first jet to an executive operator this year—Timken Roller Bearing will get one of the twin-jet four-place Morane-Saulnier MS-760s for which Beech is distributor.

Cessna is shooting for over 50% of the business flying market in 1958 with a line expanded to six models including the new Model 175—a four-place tricycle gear airplane with a geared 175-hp. Continental carrying a list price tag of $10,995—and its new Skylane, a deluxe version of its Model 182. Company is aiming to turn out 3,200-3,500 commercial units this year, with some 800 of them being the new 175. Deliveries of Skylane started late last year; new 175 will be publicly announced at nationwide dealer showings Mar. 22-23.

And the firm expects earnings this year to increase over 1957 in spite of planning to write off more than $2 million in costs charged to its canceled four-engine pressurized Model 620.

Business Flying 1946–1970

	Hours (000's Omitted)	Miles (000's Omitted)
1946	1,068	121,530
1947	1,966	228,125
1948	2,576	298,945
1949	2,615	309,062
1950[1]	2,750	339,700
1951	2,950	379,845
1952	3,124	419,705
1953	3,626	499,166
1954	3,875	552,610
1955[2]	4,300	614,900
1956[3]	4,580	691,420
1957[3]	5,000	800,000
1960[3]	5,700	997,500
1965[3]	7,807	1,483,300
1970[3]		
Low	9,000	1,710,000
Intermediate	9,929	1,886,500
High	11,000	2,090,000

Sources: 1946–1954, CAA Annual Survey of Aircraft Use; 1955–1970 CAA Program Planning Office.

1. Data satistically computed from trend since no formal survey made by CAA in 1950.
2. Based on preliminary data.
3. Estimates.

But business flyers still will have available a small pressurized piston-engine airplane tailored to their needs: Aero Design & Engineering Corp. plans to start deliveries of its new Alti-Cruiser, a pressurized 680 Commander, next month. Company expects to sell 50 of these airplanes this year, with a price tag of $183,750.

Work on 1959 and 1960 models is well along—Piper is flight testing a modified Apache fitted with 250-hp. engines which it is using as a testbed for its new Aztec light twin, which will be a 200-mph. plus airplane; Mooney is flying an aerodynamic prototype of its Mark 22, a light twin aimed at a price tag of under $30,000; Cessna has a new two-place light utility airplane, the Model 150 coming along for production next year with a price tag of about $7,000.

New Designs

Many new designs are planned around the upcoming generation of in-line powerplants in the design and test stage at Continental and Lycoming, who feel that this class still has a long life ahead of it before it is replaced by the turbine powerplant. Indications are that these new piston engines will reach up to at least the 500-hp. range to fill the gap left when development of the Wasp and Whirlwind radials ceased. These will embrace flat configurations covering supercharged, geared and fuel injection configurations.

Current low production rate and military status of current light turbine and turboprop engines would tend to keep them from being available in quantity to business users for several years.

Recent survey by Piper Aircraft Corp. of owners of its airplanes provides interesting composite picture of current business plane operator. Based on questioning some 7,000 Apache twin and Tri-Pacer operators, data shows

the average Tri-Pacer operator to be a professional or businessman having a private pilot rating in 7 out of 10 cases and with 1,733 hr. flying time logged.

He flies his Tri-Pacer an average of 25.5 hr. monthly with himself and one passenger 66% of the time and two or three passengers 34% of the time. A survey of 85% of the replies shows that he or his firm owns only one airplane; but four cases out of 10 show that he owned another Piper airplane before he purchased the Tri-Pacer.

Owner averaged some 37,000 mi. flying last year with 61% of this on business and the remainder on pleasure or vacation trips. According to the survey, 11% of Tri-Pacer owners are qualified instrument pilots.

Average Apache owner, or hired professional pilot, has a commercial or transport rating, in 58% of the replies, and has averaged 3,020 hr. flight time. Apaches were flown an average of 64,000 mi. in the past year, 84% of the time on business carrying two to four people 60% of the time and a single passenger only 40% of the time. Ownership survey shows that 80% of Apache operators do not own another airplane and 18% of them have owned Piper airplanes previously.

Best available information currently indicates that about 15,000 of today's business plane fleet are equipped for instrument flying, but actually a low percentage of them are flown by instrument-qualified pilots. The Piper survey shows that only 11% of Tri-Pacer owners are instrument qualified and yet 84% of the Tri-Pacers covered are Super Custom models, having complete radio and navigation equipment. In the Apache class, 83% of these airplanes are completely fitted, yet only 20% of the owners or company pilots have instrument ratings.

CAA Study

Civil Aeronautics Administration is studying this capability and thinking seriously about revising current pilot training standards to bring them up-to-date with today's requirements for higher standard of piloting considering complexity of air traffic.

One experiment it has watched closely is that run at University of West Virginia under sponsorship of the Link Foundation. Here 10 students received three to five hours of instrument flight training during 40 hr. of flight training using a Cessna 140 and 170A equipped with complete panels. Two of these ten students continued and received 20 additional hours of instrument work and were tested and found capable of obtaining an instrument rating.

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Demand High for Agricultural Airplane

Demand for the agricultural and utility airplane holds a steady upward pace—crop controls and soil banks notwithstanding—and spray/dust operators have seen their gross income rising to some $90 million annually compared to approximately $70 million of just two years ago.

Progress is highlighted by the fact that operators and pilots have achieved this growth with little industry support in the way of equipment or promotion—their achievements have been won the hard way with aggressive selling, ingenuity and hard-won skills, using considerable amount of obsolete self-designed equipment and constantly faced with shortages of skilled manpower.

There are few signs that replacements are on the way for their aircraft. Some custom-designed prototypes are flying, but for the main part they appear to be too expensive to purchase, particularly for those operators who are thinking in terms of large fleets. Most of the military planes now being made surplus—a former key source of replacement aircraft—appear to be unsuited for agricultural and other utility duties. Significantly there has been considerable trend toward use of small aircraft for agricultural use, with Piper Super Cub being by far the most popular type.

Indications are that this manufacturer is busy developing a new higher-performance light agricultural plane for this market. The new Piper project, which is expected to appear this year, is being developed by the company's independent design group at Vero Beach, Fla., headed by Fred Weick, one of this country's top agricultural specialists.

Boom Period

With improved aircraft, dispensing equipment and chemicals, agricultural aircraft operator would probably enter a sharp-rising boom period. Many of the new chemicals sought by the agricultural operator would hasten harvesting seasons, also speed preparation of soil for new harvests. Indications are that greater use of aerial fertilization, as sponsored by New Zealand government, will be hastened by development of new chemicals having a high ratio of nitrogen to chemical weight, making aerial application more economical and practical. Some new products in this field have about four times higher concentration of nitrogen than earlier types.

New role for the utility airplane that shows considerable promise is that of fighting forest fires from the air. Experiments thus far have shown enough promise to indicate that this should be a profitable field in coming years for aircraft operators. Last year U. S. Forestry Service used aircraft for some 8,500 hr. on forest fire missions; some 2,100 hr. being taken up by aerial tankers on dispensing water and chemicals to douse conflagrations.

Forest Service favors use of a borate slurry—mixture of chemical and water to hit blazes. Planes chartered by the service dropped a little over 600,000 gal. of this solution on forest blazes last year in addition to some 337,000 gal. of water. In previous year, drops comprised approximately 43,000 gal. of borate slurry and 40,000 gal. of water.

So successful have been these early tests, that use of aerial tankers has become standard procedure in fighting forest fires in California and the Forest Service forecasts a rapid spread of these techniques to other regions.

Instructional flying showed sharp increase last year, with Civil Aeronautics Administration reporting 78% jump in issuance of student certificates. Student certificates totaled 80,290 in 1957. Private pilot certificates also increased 48%, a total of 25,863 and commercial pilot certificates gained 95%, a total of 32,711.

Growth of business flying is attributed as the major factor in jump in student licenses, but there is also an undeniable increase in interest by the public in flying for pure pleasure, although Civil Aeronautics Administration has no recent statistics to define the exact measure. Accurate statistics will have to wait until later this year after CAA is able to evaluate results of a new study it will start in several months aimed at updating early data.

Two-Place Market

For the first time in several years several major aircraft manufacturers are studying the personal two-place airplane market. However, it seems doubtful if a new airplane in the under $5,000-class will be available from this source—an educated guess would place price closer to $7,000.

GRUMMAN studied spray/dust market with new biplane (above).

CLOUD SEEDING lessens lightning storm intensity (below).

FLY WEATHER-WISE — Mobil

These weather items prepared in consultation with the United States Weather Bureau

TEMPERATURE VARIATIONS

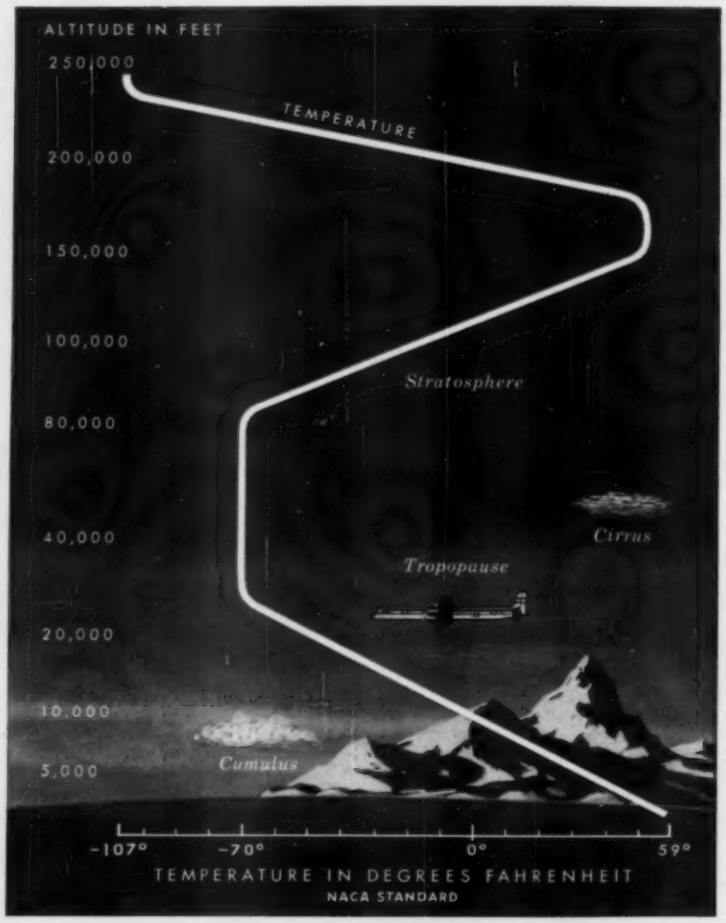
IN RELATION TO ALTITUDE...

TEMPERATURES encountered in a single flight may vary as much as 130°F. or more. These variations are associated with altitude and weather patterns and can affect flight performance.

Temperature and altitude—Heat from the earth warms the atmosphere with steadily decreasing effect as altitude increases. Temperature normally decreases with altitude at the rate of 3½°F. per 1000 ft. At the tropopause (top of troposphere) temperature remains almost constant up to 80,000 ft. Therefore, modern aircraft encounter coldest air in the tropopause layer which varies from about 28,000 ft. in the polar air masses to 54,000 ft. in the tropical.

As altitude increases from approximately 80,000 ft. to 150,000 ft., the temperature returns to almost sea level condition. This is the result of strong absorption of the sun's ultra-violet rays in the layer of ozone gas at very high altitudes.

At still higher altitudes, the temperature reverts to extreme cold.



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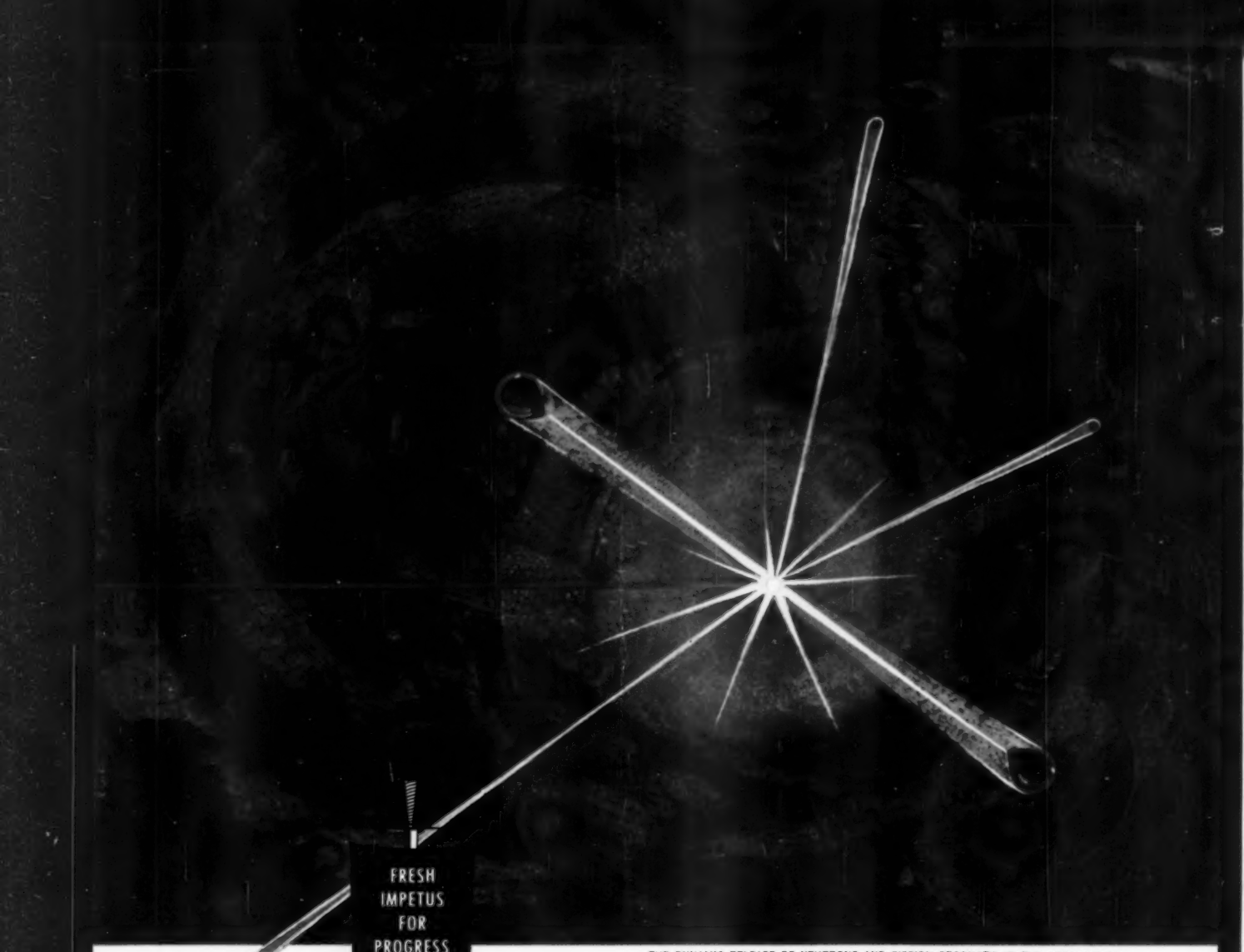

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RUSSIAN ground-to-air missiles roll into Red Square during Nov. 7 parade celebrating 40th anniversary of Red revolution.

Soviets Hike Post-War Weapons Gains

By Robert Hotz

Soviet Union made its most spectacular post-war gains in aerial weapons development during 1957. Even though warned by nearly three years of surprising Soviet development pay-offs in this area, western observers were almost completely unprepared for the shock of the Russians' successfully test firing an intercontinental ballistic missile in July and putting the first two Earth satellites into orbit in October and November. Although the ICBM firings and the satellites were the most spectacular Soviet technical achievements they were only part of the broad spectrum of aerial weapons development in which the Soviet Union unveiled substantial new achievements during 1957.

Among the other new Soviet developments were:

• **Flight testing of a new** heavy jet bomber developed as a longer range and higher performance successor of the Bison bomber.

• **Series production of a Mach 2** delta wing fighter (Fishpot) powered by a 22,000 lb. thrust turbojet.

• **Flight testing of a new Mach 1.5** light bomber (Backfin).

• **Flight testing of a new family** of turboprop and turbojet transports, including the Il-18 Moscow turboprop transport, the An-10 Ukraine turboprop transport, the Tu-110 four-jet transport and the Tu-114 Russia giant turboprop transport capable of carrying 120 passengers nonstop from Moscow to New York.

• **Flight testing of the Mi-6** (Hook) jet-powered helicopter that lifted a 24,000 lb. payload to an altitude of over 7,000 ft.

• **Development of an operational** aerial refueling capability for both Bison and Badger jet bombers using the "buddy" system concept with probe and drogue type equipment.

• **Achieving operational** status of the T-2 (M-103) two-stage intermediate range ballistic missile in launching areas that brought Western Europe and most of North Africa within range of these weapons.

Soviet Sputniks were the jolt that finally aroused the U. S. from its technical smugness and political lethargy although there has been a steady flow of solid warnings on the rise of Soviet military technology dating back to the combat with the MiG-15 jet fighter in 1951 over Korea. Although many political leaders scoffed at any military implications of the satellites, aviation leaders everywhere clearly recognized them as the first step of man into space and the beginning of space weapons development.

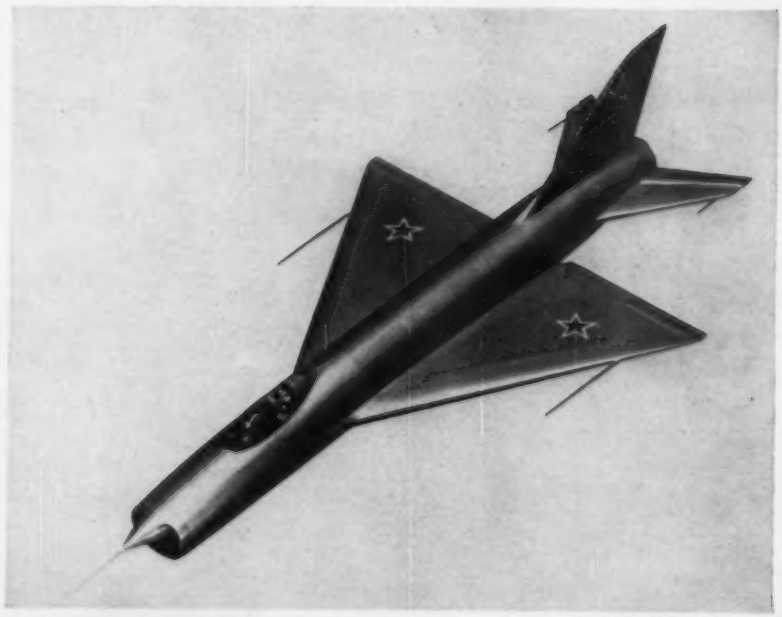
Prestige Builders

The Soviet Sputniks prove that the Russians won the race to be first in space and reaped the tremendous international prestige harvest that inevitably accompanied a victory of such magnitude. However, the Soviets are still a long way from mastering space and employing it for useful purposes, either peaceful or military. This race between the Soviet Union and the U. S. to master space will be the focal point of the international technological race during the next decade.

One of the primary reasons for the Soviet launching of a successful Earth satellite first was the fact that, following normal technical logic, they uti-

MIG-19 FARMER

YAKOVLEV FLASHLIGHT C



SUKHOI DELTA FISHPOT

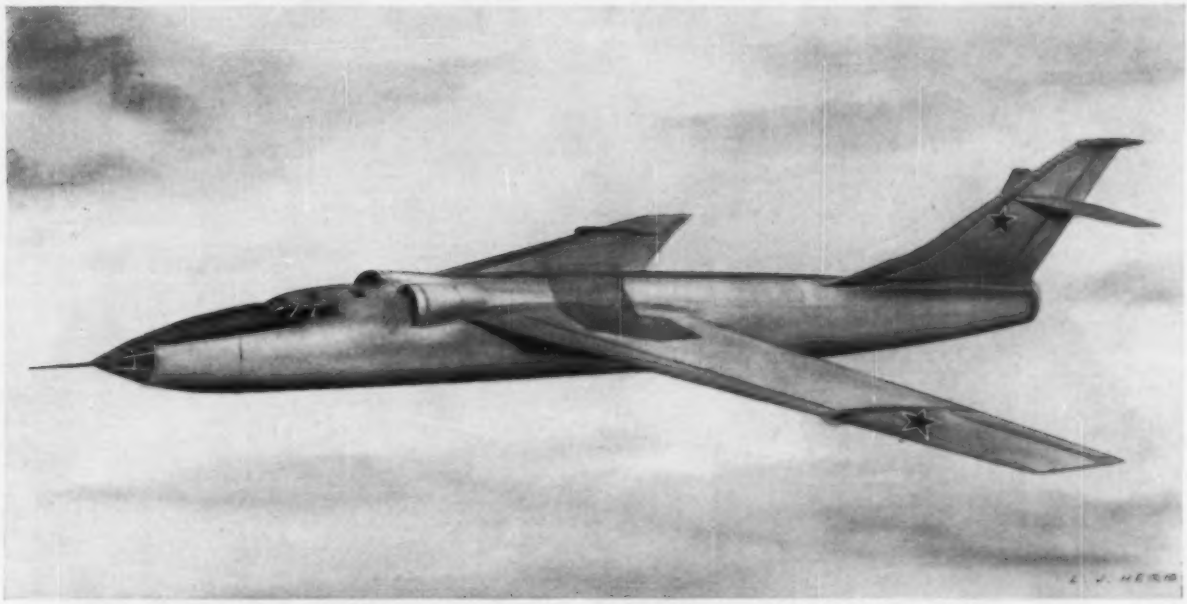
lized the available propulsion and guidance hardware from their intercontinental ballistic missile development program for their Sputnik program. The U.S. policy, in contrast, deliberately barred the satellite program from using any of the readily available military missile hardware. Instead, it directed a completely new design project for the Vanguard program which embodied considerable technical sophistication and state of the art advances, all at the expense of time. Given these two divergent technical policies it was almost inevitable that the Soviets should win the satellite race. The successful launching of the first U.S. satellite, Explorer, early in 1958 with well proven, off-the-shelf hardware from the Army's Redstone, Jupiter and Sergeant missile programs again emphasizes the soundness of the original Soviet approach.

Soviets Plan for Space

Although there has been a lag between the Soviet launchings of the 187 lb. Sputnik I last October and the 1,200 lb. Sputnik II in November, there is no reason to suppose that the Soviets have slowed the pace of their step-by-step exploration of outer space. It is inevitable that they will encounter failures as they progress to more sophisticated space vehicles. Indeed, there is good confirmation of an abortive attempt last September that preceded the successful Sputnik I launch. But Soviet technical literature during the past few years has painted a pretty clear picture of the Russians' understanding of the importance of an active space program leading to useful space vehicles and a burning enthusiasm to make the dreams of their native space pioneer, Konstantin Tsiolkovsky, come true.

The Soviet Sputnik launching system, according to Russian sources, was the same three-stage, liquid-fueled rocket system developed for the intercontinental ballistic missile. The Soviets began first flight testing of this system late in 1956 and by early 1957 were making stage tests from their missile test center at Krasnyy Yar near Stalingrad. The first successful full range test of the intercontinental ballistic missile prototype was made in July, 1957, with a 3,750 mi. flight from Krasnyy Yar to the Bay of St. Peter near Vladivostock. At least one other successful full range flight was made before the Soviets announced in August that they possessed an ICBM. The Soviet ICBM known as the Type Three or M-104 is a three-stage vehicle capable of carrying even an old style heavy thermonuclear war head of several megaton yield over about 4,000 mi.

Its initial stage consists of two 228,000 lb. booster rockets fueled by liquid oxygen and kerosene. Second stage consists of the Type Two (M-103) inter-



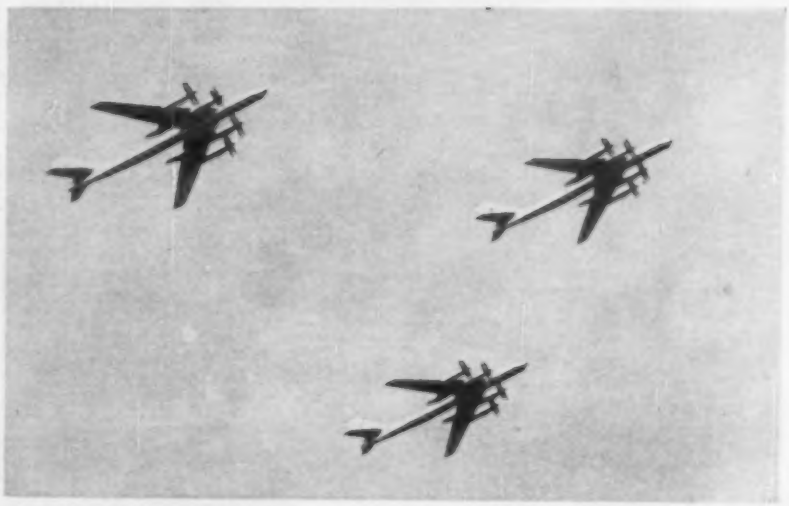
BACKFIN TWIN-JET BOMBER

mediate range missile first stage propulsion system utilizing a 225,000 lb. thrust lox and kerosene fueled rocket. Third stage is another liquid fueled rocket at present, although experiments have been conducted with a solid fuel third stage.

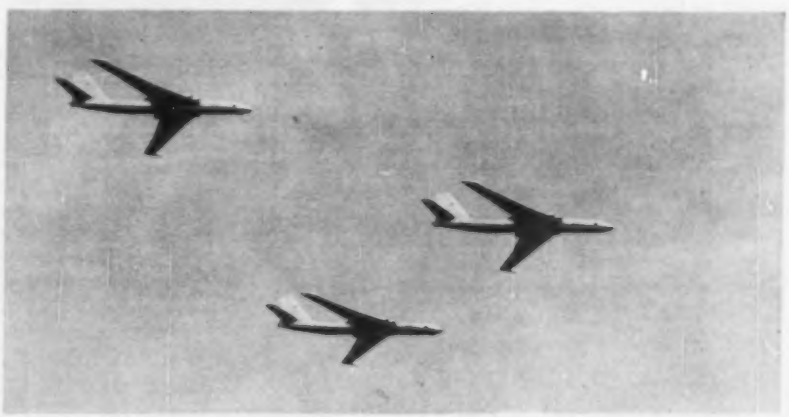
It was obvious during the early months of 1958 that the Soviets do not yet have an operational ICBM fully tested to the degree of reliability required for a usable weapon, although some intelligence sources estimate they have built as many as 500 T-3 ICBM systems. Assuming a normal rate of top priority development testing, it would appear that the Soviet ICBM would become a factor in the international military balance during the last half of 1958 and play an extremely significant role in 1959. Public indications that the Soviets have a genuine ICBM capability will probably include a renewed political attack on the North Atlantic Treaty Organization; an attempt by Soviet leaders to deprecate the capabilities of manned aircraft in an attempt to undermine NATO confidence in the USAF Strategic Air Command, and a generally more aggressive foreign policy.

ICBM Development

The Soviet ICBM development was the climax of a 12-year top priority development effort based primarily on a foundation of German World War II missile achievements at Peenemunde and the Russian solid fuel rocket development during World War II. Soviets began with the 175 mi. range liquid-fueled V-2 ballistic missile, the Wasserfall infrared guided anti-aircraft



BEAR TURBOPROP BOMBERS



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rocket and the theoretical work of Professor Eugen Saenger on a hypersonic skip bomber. The Soviet military parade of Nov. 7 in Moscow demonstrated publicly for the first time a wide family of ballistic missiles based on the German developments. These included long-barreled rocket guns capable of launching a three-stage rocket projectile such as the German Rheinbote development; improved, solid-fueled versions of the Wasserfall anti-aircraft missile; two types of short ranged solid propellant missiles corresponding to the U.S. Army's Honest John and Little John; a liquid fueled 200 mi. range missile equivalent to the Army's Redstone and the Type One (M-101) liquid fueled missile with a range of about 500 miles. All of these missiles were mounted in extremely mobile launchers, most of them with caterpillar treads, armored and carrying crews that could launch the missiles without leaving their armor protection.

Soviet IRBM

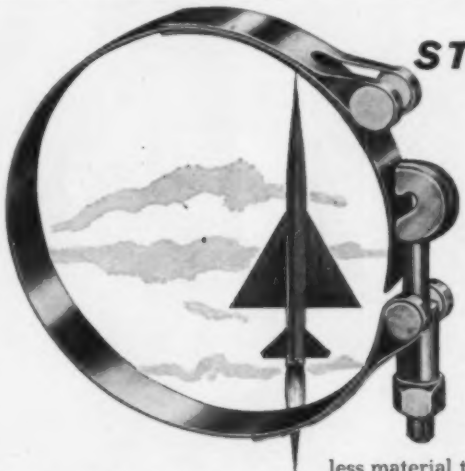
Not shown was the Soviet IRBM the Type Two (M-103). This two-stage missile uses an initial stage 225,000 lb. thrust liquid fueled rocket and a smaller rocket, probably the T-1 propulsion system as the second stage. It began experimental flight testing early in 1955 and, by the middle of 1956, it was being tested at a steady rate of about five per month from the Krasnyy Yar launching site, indicating it had shifted from experimental development testing to production testing. The T-2 is now operational with the Red Army and an estimated 1,500 of these missiles have been produced for operational uses and production testing. The T-2 has a range of about 1,000 mi. and, from its current launching areas in eastern Europe and southeastern Russia, it can cover most of the NATO air bases in Western Europe and the North African littoral.

The Soviets are also known to be working on a hypersonic glide bomber for which an 825,000 lb. thrust liquid fueled rocket has already reached the test stage. Whether the Soviets have discovered the basic flaws in Prof. Saenger's theories is not yet as clear as their determination to push this project as a top priority development.

All of the Soviet medium and long-range ballistic missile developments utilize propulsive systems far more powerful than those designed in the U.S. to hurl megaton warheads over the same distance. The smaller U.S. rockets are possible because of some spectacular work by the Atomic Energy Commission in reducing the size and weight of the thermonuclear warhead. Virtually all ballistic missile development was suspended in the U.S. until this warhead breakthrough had been demonstrated. In contrast, the Soviets continued the steady pace of their development work regardless of the large size and weight of megaton warheads that appeared inevitable five years ago. Instead of waiting for progress that would reduce the warhead size and weight, they proceeded to develop the huge rockets that would have been necessary to hurl the old style warheads to the U.S. As always they have found that a surplus of power is a handy dividend for the aerial vehicle designed. This has paid off in the size of the Sputniks they were able to launch in comparison with the 18 lb. Explorer and the 21 lb. Vanguard satellites. The propulsive force required to put the Sputnik II into its orbit is the equivalent of that force required to hurl a 5,000 lb. warhead over a 5,000 mi. range.

Aircraft Not Neglected

While pushing their missile and space programs at top priority, the Soviets have not neglected the development of manned aircraft over a wide spectrum, ranging from nuclear propulsion and heavy bombers to jet transports, helicopters and bush planes to develop the Siberian wilderness. To foreign observers who have followed the Soviet development program from the first indications of its pay-off stage some



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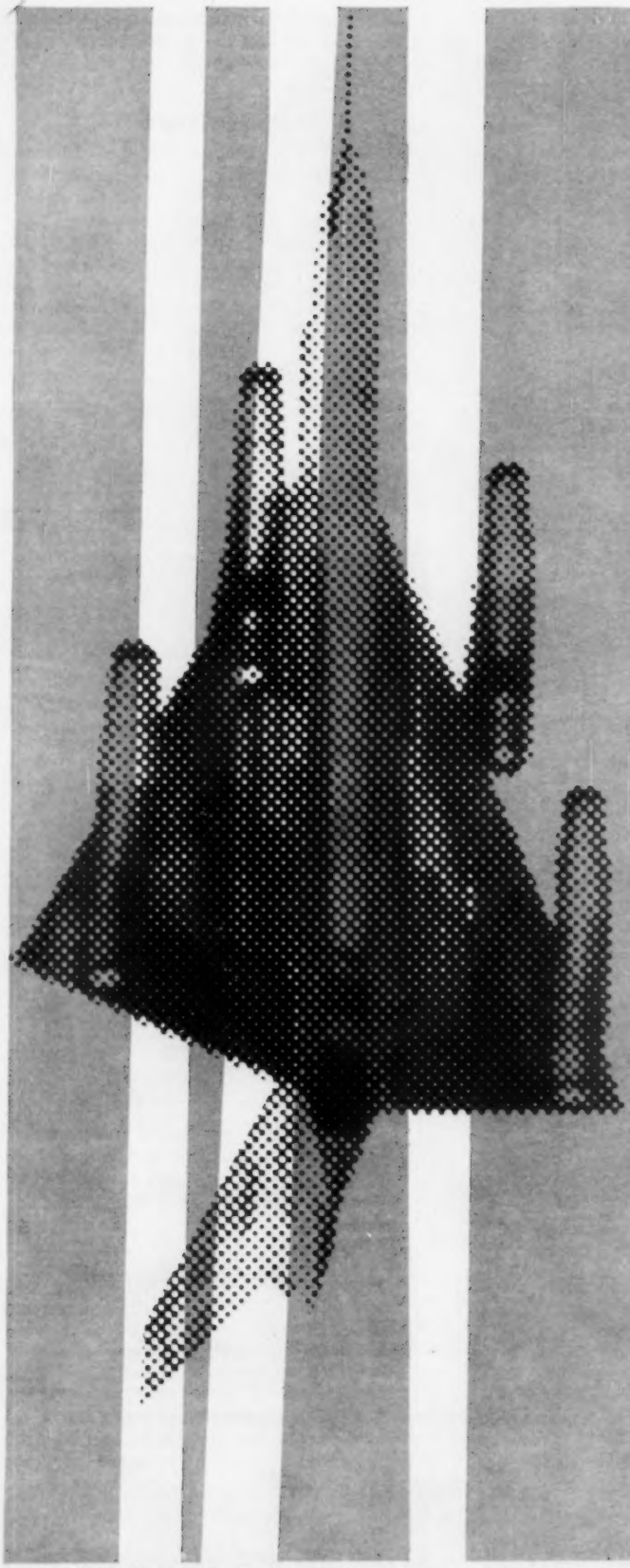

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four years ago, it is this extremely broad spectrum of their military technology that is even more impressive than their rate of recent progress.

Although Nikita Khrushchev publicly trumpets that the advent of ballistic missiles has made manned aircraft obsolete, his air force planners and design teams are pushing hard on a variety of new manned bomber programs. During 1957, the Soviets announced they had successfully test flown a new heavy jet bomber. Although no details are yet available on this new bomber, it appears that its development as a replacement for the short legged Bison bomber rather than the advent of missiles was responsible for the lack of anticipated acceleration in the Bison production program. The Bison, although startling evidence of Soviet progress, did not measure up to the performance requirements in either speed, altitude or range of a contemporary heavy bomber such as even the early model B-52s. Solid indications last year of a leveling off in Bison production rates at a relatively low level were cited by some U. S. optimists, such as Deputy Defense Secretary Donald Quarles, as evidence of earlier over-estimating of Soviet abilities. Instead, it appears more likely that the new heavy bomber has been brought through to replace the Bison whose role now appears to be strictly as an interim stop-gap. The

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MIG-21 FACEPLATE

Soviets are also working hard on a nuclear propulsion system for aircraft and expect to fly their first experiment of this type soon utilizing their nuclear powerplant in a Bear bomber airframe. Soviets also have admitted publicly that they have developed exotic chemical fuels such as the boron compounds now being tested in this country. There is no reason to suppose that they will not apply these fuels to their manned aircraft program.

Jet Transports

Although the annual Tushino air show was canceled in 1957 due to the political struggle between Nikita Khrushchev and Marshal Zhukov for top spot in the Soviet hierarchy, several new aircraft appeared in the Moscow skies. Next to the new heavy bomber perhaps the most significant were the family of jet transports described to AVIATION WEEK by top-level Soviet sources in July, 1956 (AW July 22, p. 26). This family of turboprop and turbojet powered transports are the backbone of the Soviet bid to become a world power in international air transport and to use air transport as a major tool in developing its internal economy. At one end of the spectrum appears the mighty Tu-114 capable of carrying 120 passengers nonstop from Moscow to New York at a cruising speed of about 500 mph., and at the other the An-14, the "Little Bee" designed by Oleg Antonov as a bush plane to help develop the internal frontier of the Soviet Union. The An-14 is designed for operation in and out of short, unimproved fields, cruises at 143 mph. and carries 6 passengers.

In the development of Russian postwar transport aircraft, it is interesting to note Oleg Antonov's concentration on aircraft that are specifically designed to operate on the relatively small, grass fields and level ice found at the vast majority of Soviet airports. His An-2 Colt has proved to be the workhorse of Soviet aviation, both civil and military, in the Arctic and the backwoods of the Communist domain. It operates on floats, skis and wheels and performs much the same function in the Soviet system as the de Havilland Beaver and Otter do in the Canadian wilderness. The An-14 is aimed at getting into even more inaccessible places than the Colt could negotiate and spreading air transport down to a whole new strata of Soviet inhabitants.

Another Antonov design, the An-4 Camp, was the first Soviet assault transport specifically designed to operate in and out of unimproved fields with self contained loading ramps and with a cargo floor level only the bare minimum height above the airfield.

An-10 Turboprop

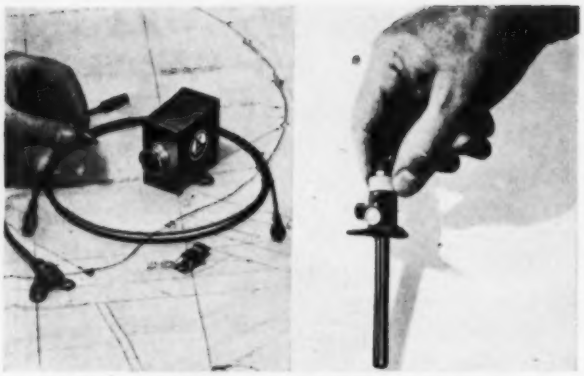
Similarly, the An-10 giant turboprop transport roughly the size of the Lockheed Electra also was designed with the unimproved airport in mind. It has integral loading doors, an integral cargo ramp, low floor level and a double bogie landing gear with low footprint pressure for grass or roughly cleared fields. In contrast, the Ilyushin Il-18 turboprop transport of roughly the same size follows the western design style of high tricycle landing gear and tubular fuselage suitable only for passengers. It is obviously designed for the international services of Aeroflot where comparison with western equipment will be made; where runways are long and solid, and where conventional ground handling equipment will always be available.

The other two new Soviet transports to appear during 1957 were both Tupolev jet designs—the Tu-104A, a high density seating version of the original Tu-104 jet transport also featuring improved jet engines; and the Tu-110, a four-jet transport offering higher seating capacity, a slight increase in speed and more range than the Tu-104. The Tu-110 is apparently designed for internal Aeroflot service on 1,000-2,000 mi. stage lengths and for service linking Moscow and the main capitals of western Europe.

Policy Shift

It also is interesting to note a major shift in Soviet air transport development policy that became evident during 1957. The original Tu-104 represented an attempt to get a jet transport operational as soon as possible without regard for the normal operational economics sought in a commercial transport. The Tu-104, as a result, is a basically uneconomical transport for routine airline operations but accomplished its purpose as a showpiece to demonstrate that the Soviets were pulling abreast technically with western aviation.

But in the next generation of gas-turbine-powered transports, the theme of economy of operation was strongly evident. The heavy cabin furnishings of the Tu-104 and prior Soviet transports were replaced by plastics, foam rubber and lightweight metals. Instead of the elaborate luxury of the 50-passenger Tu-104 interior, high density



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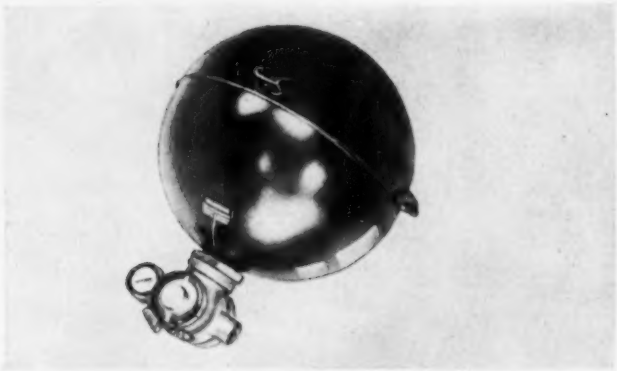

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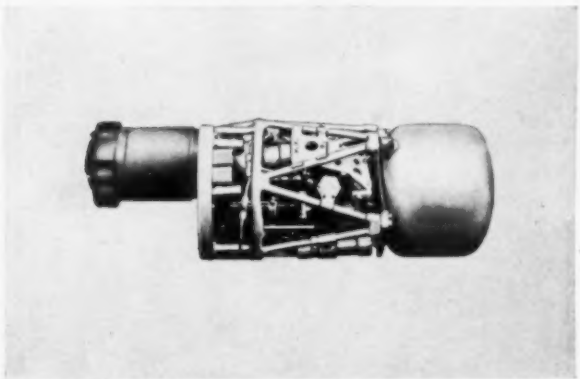

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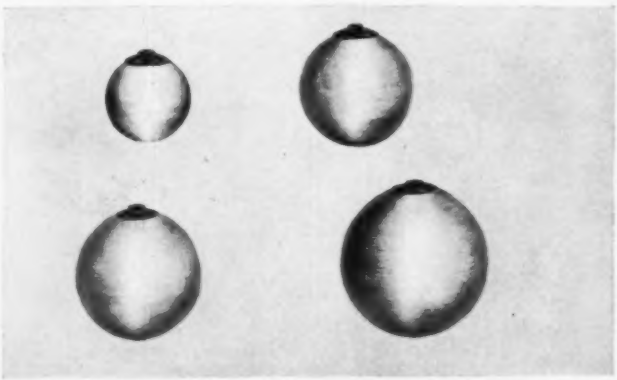

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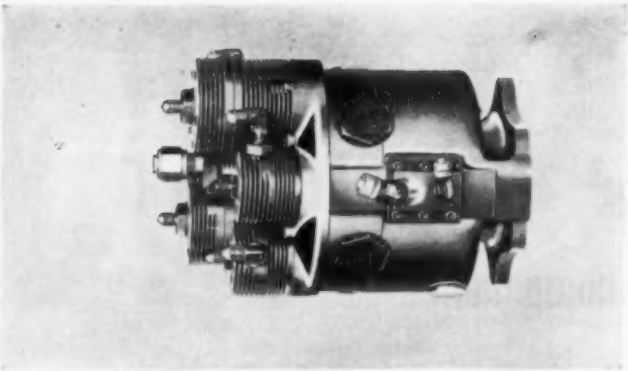

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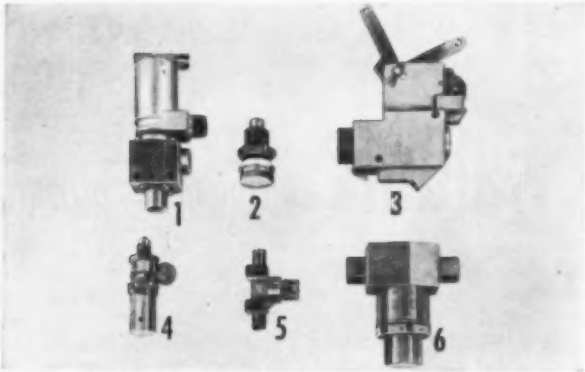

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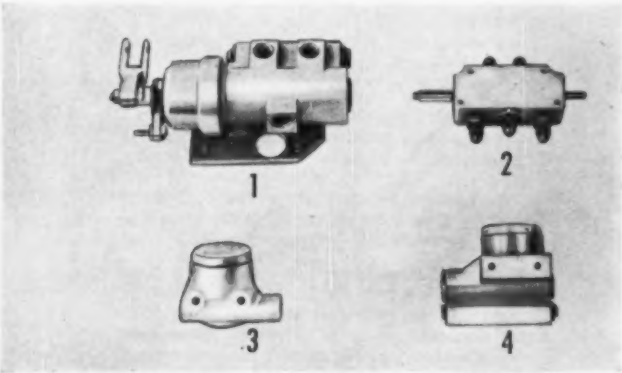

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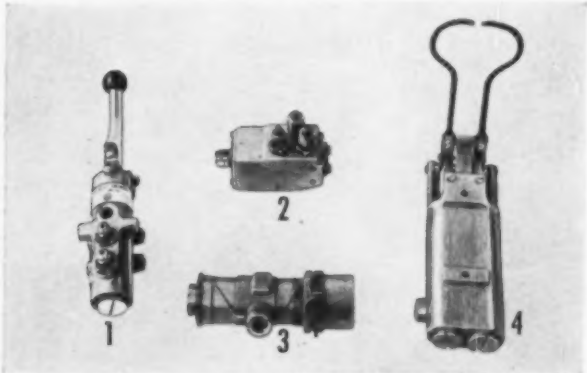

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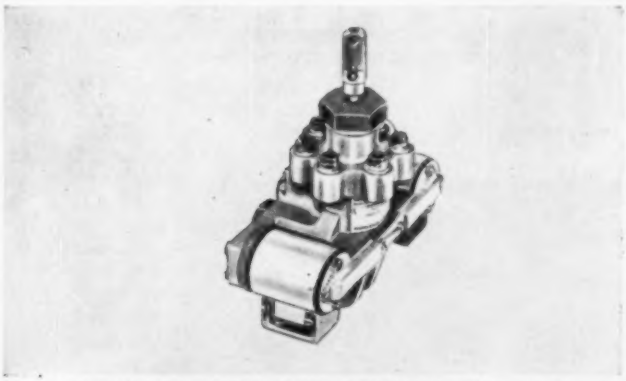

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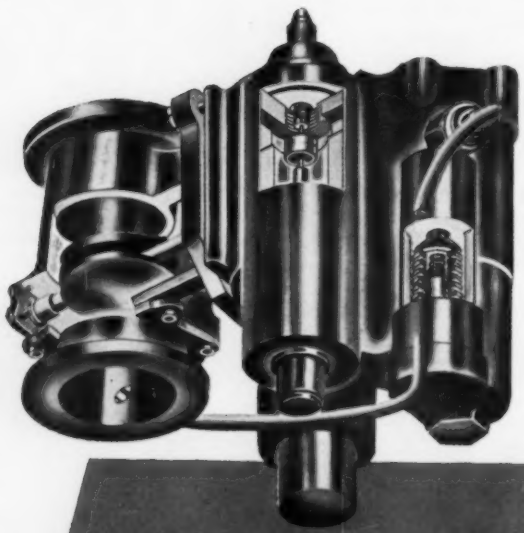

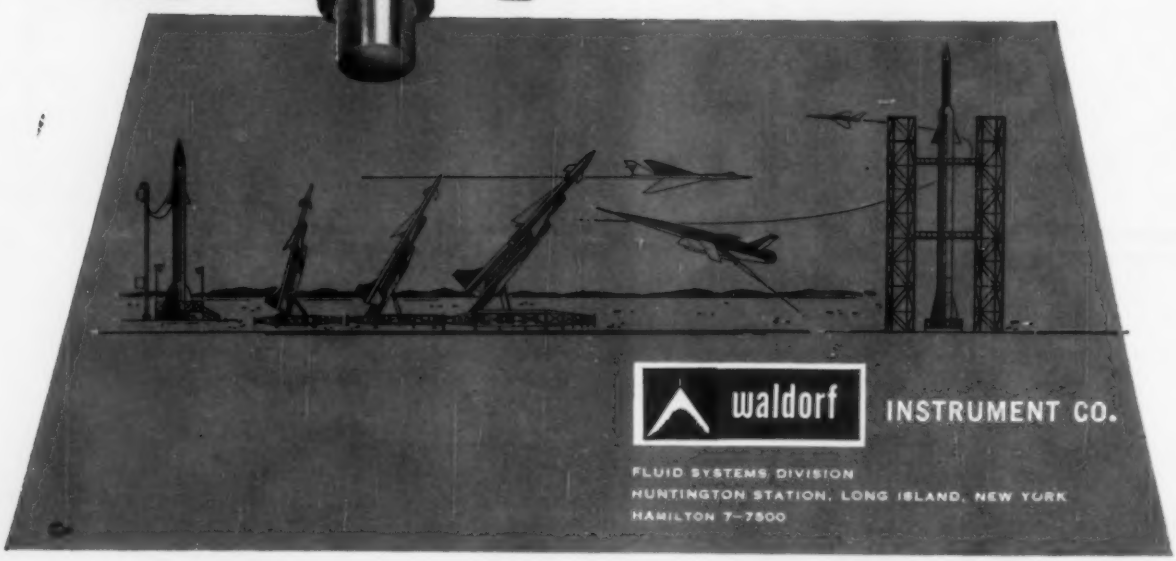

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seating became the theme with the 70-passenger version of the Tu-104A and the 100-passenger configurations of the Il-18, An-10 and the 170 maximum capacity of the Tu-114. For the first time in post-war history, Aeroflot officials are talking about high density, low-fare operations that will successfully compete with rail fares.

Air Force Modernizes

Militarily, the change of the Red Air Force from the subsonic MiG-15 to the Mach 2 fighter types now in production, such as the MiG-21 and the Sukhoi Delta (Fishpot), is exemplified by the change in the Red Air Force pilot's personal equipment. Two years ago virtually all published pictures of Red Air Force flight crews found them still wearing leather jackets, trousers stuffed into high boots, leather helmets and relatively crude World War II style oxygen masks.

During 1957, pilots suddenly blossomed with hard helmets with built-in polaroid visors and fitted demand-type oxygen masks, and test pilots began appearing in full pressure suits comparable to the operational styles currently used by USAF and Navy pilots but a generation behind the equipment developed for use by the X-15 pilots.

During 1957, Mach 2 fighters began appearing in squadron service with the Red Air Force with the MiG-21 (Faceplate) superceding the MiG-19 (Farmer) as the standard operational fighter. Formations of Fishpot Deltas were seen in the air over Moscow, an indication that it has progressed beyond the experimental prototype stage when it was first publicly demonstrated at the Tushino air show of 1956.

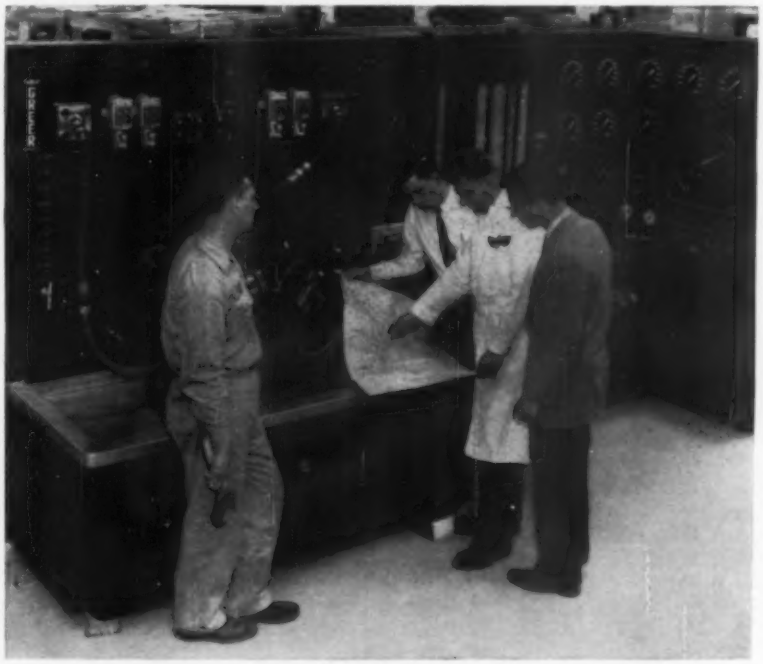
Evidence that the Soviets are also continuing development of light jet bombers came with the appearance of the prototype Backfin during the summer of 1957 over Moscow. This bomber is a successor to the barely sonic Blowlamp seen at Kubinka airfield in 1956 and has a performance in the Mach 1.5 area. It is powered by two 17,000 lb. thrust turbojets with shoulder air intake mounted above the swept back wing.

Aerial Refueling

Another interesting military development is the widespread use of aerial refueling by Bison bombers and the discussion of aerial refueling techniques that appears in the Soviet popular and technical press. After experiments with both the flying boom and probe-and-drogue types systems, the Soviets have standardized on a probe-and-drogue system utilizing a tanker conversion kit for the Bison that enables it to be used as either a tanker or a bomber for a specific mission. This provides considerably more logistic and operational flexibility than the USAF system of providing a separate tanker type aircraft to service bombers.

There was also considerable evidence during 1957 that the Soviet air defense system was growing significantly stronger. The subsonic Yak-25 (Flashlight) all-weather fighter was replaced in service by the supersonic Flashlight C first seen at Tushino in 1956. The new Flashlight is equipped with air-to-air missiles. Anti-aircraft missiles now in service use a two-stage solid propellant system with an infrared homing device. They have a range of close to 100 mi. and are expected soon to be equipped with nuclear warheads comparable to the Nike-Hercules.

Helicopter development continued to progress during 1957 with the appearance of Mihail Mil's Mi-6 twin-jet-powered helicopter that proved its performance in an officially-observed Federation Aeronautique Internationale record claim for lifting a 12-ton payload to 7,000 ft. altitude. The Mi-6 is powered by two 4,000 lb. thrust turbojets mounted above the main cabin and uses a five-bladed single rotor reminiscent of the Sikorsky designs. It is equipped with an integral rear loading ramp and clamshell doors that permit the loading of vehicles.



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ENGLISH ELECTRIC P.1B INTERCEPTOR

Military Cuts Offset British Exports

By David A. Anderton

London—Peak year, bleak year; this was 1957 for the British aircraft industry. Exports of military and civil aircraft, engines and parts hit a new high of £116.5 million ($332 million), running a close second behind the money-making capabilities of Scotch whiskey, long the prime export of these islands.

The order book for the year shows about 460 military planes worth about £100 million ($286 million) with India the leading customer, having bought 68 English Electric Canberras and more than 100 Hawker Hunters for a total cost of about £50 million ($143 million).

West Germany ordered Hunting Pembrokes, 68 Hawker Sea Hawks built by Armstrong Whitworth, 16 Fairey Gannets and 10 Saunders-Roe Skeeter helicopters. Switzerland bought 100 Hawker Hunters at the beginning of 1958, although the order was all but officially approved in 1957, plus 20 DH Vampire trainers. Venezuela came through with a repeat order for about one dozen Canberras.

Royalties received from licenses abroad would probably add another £7 million or so ($20 million) to the total.

But countering this was the first year under the restrictions of the Defense White Paper, which made drastic cuts in all three military services and brought manned fighter and bomber development in Britain to a dead stop in 1957.

Victims of its ax included Saunders-Roe P.177 mixed-powerplant interceptor and the Hawker P.1121 ground-support aircraft. Further economies killed the promising Bristol Orion turboprop engine and stopped support of the de Havilland Gyron turbojet.

The drawback is that the old warhorses of export—the Hawker Hunter, English Electric Canberra, and the de Havilland Vampire—have just about reached the end of their useful lives. Foreign sales of these types will probably dwindle to zero in the next year, and where are their replacements on the world's markets? Not in British factories.

Even that perennial money-maker, the Vickers Viscount, began to slow down during the past year. Vickers only took on 18 new orders during 1957 for the turboprop plane.

FOLLAND GNAT LIGHT FIGHTERS

Civil Transport

So with one exception—the order for the de Havilland 121, British European Airways' medium-range jet—there is no prospect of a new civil transport order in Britain.

Neither is there a new specification for a military aircraft, and all the injured screams from industry apparently aren't going to change the current situation.

Any industry heading into a new year with such bleak prospects would think twice before pressing on regardless, and there are some indications that kind of thinking is being done.

First steps in this direction were taken during the preliminaries to the BEA order. Out of the necessity for self-support of the development project rose two synthetic organizations: Hawker-Siddeley Bristol Co., formed from a combination of these two giants of Britain's aircraft industry, and Airco, formed from a combine of de Havil-

land, Hunting Aircraft and Fairey Aviation.

Consolidations of this type had been discussed for a long time and recommended by critics and observers of the industry here, but never accomplished. The view of most members of the industry was that such consolidation would come about, but not by being forced upon the companies by a government policy.

That policy was clearly stated by Minister of Supply Aubrey Jones last December 2, when he said, in answer to a question in Parliament:

"Lastly it is desirable that the industry should reshape itself into stronger units. I have accordingly intimated to the industry that in placing orders for further requirements, the government will be influenced not only by the quality of design but also by the resources, technical and financial, available to complete the project quickly and successfully; and that, in so far as these criteria were not met in isolation, the government will require the chosen contractor to work in association with one or more other contractors."

Jones' "intimation" is about as far as Britain's current government cares to go at the moment, but in the political lexicon, that's equivalent to saying it had better be that way.

The day after Jones' statement, J. A. R. Kay, general manager of A. V. Roe & Co., said he believed there was only room enough for three major aircraft firms and two engine companies. It was obvious that Kay believed Hawker-Siddeley was going to be one of the three.

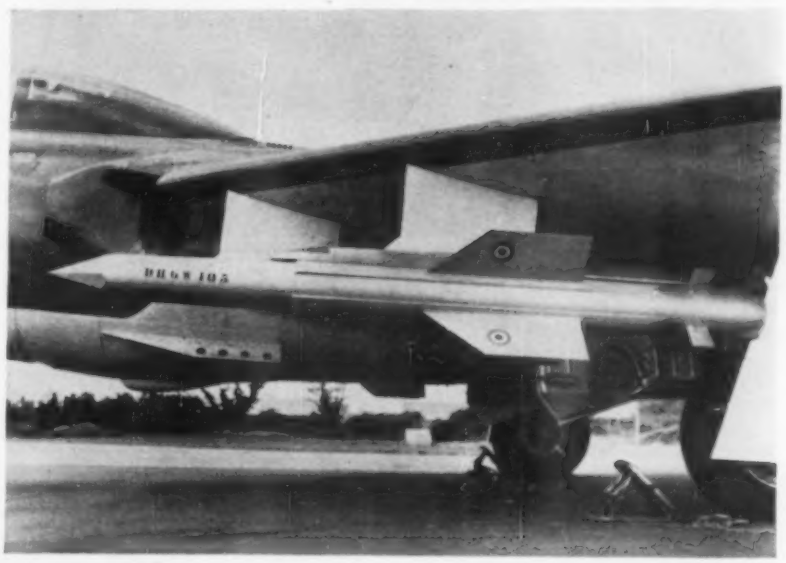
Weaknesses

More recently, Sir George Edwards, managing director of Vickers-Armstrongs (Aircraft) Ltd., said that if there were any weaknesses in the British industry it was because some companies had been given tasks beyond their capacities. Vickers has an excellent record on the production of Viscounts and the four-jet transonic Valiant bomber; but nobody was unkind enough to recall the £40 million ($114 million) fiasco on the Swift fighter.

Most observers expect further consolidations in the British industry. Logical mergers include a joining of Bristol with its major production associate on the Britannia, Short Bros. of Belfast. De Havilland, a shareholder in Saunders-Roe, might be expected to take over the smaller Isle of Wight company. Eventually there might be four major airframe combines: De Havilland, English Electric, Hawker-Siddeley and Vickers.

Whether or not this would solve the ails of the industry is still debated in some corners. Consolidation means

HANDLEY PAGE VICTOR BOMBER



DH FIRESTREAK MISSILE

A. V. ROE VULCAN BOMBER

BRISTOL BLOODHOUND MISSILE

little unless the marriage produces some offspring, and right now there are no signs that conception has taken place. Unless these joined firms can produce some new and world-beating aircraft, the export balance sheet is going to look much worse in the years ahead.

Actually a close look at the current export figures points to the danger signs. Aircraft and parts sales dropped, not substantially in percentages, but enough to indicate future trouble. The net increase in exports came from a whopping jump in engine sales abroad —Rolls-Royce alone increased by more than one-third from £21 million ($60 million) to £29 million ($83 million) which accounted for almost 35% of the export billings.

The biggest shock will come to those who have always thought of Britain as an exporter supreme in the powerplant field. During 1956 the country imported £13.2 million ($37.8 million) worth of engines, the biggest single item in the import listings, and almost equal to one-third of the engine imports.

Britain also imported aircraft and parts to the tune of £11.8 million ($33.8 million). Total imports for the year in aircraft, parts, engines, tires and electrical equipment were £26.6 million ($76.2 million), or about 23% of the exports. Some of this total was re-exported, but figures for the year are not available. However the trend has also been upward, so that the net effect is to keep the exports considerably greater than the imports.

But though the spokesmen for the industry have long pointed to its export record, they may not be able to do so much longer. The big moneymakers —military aircraft—are not going to be built.

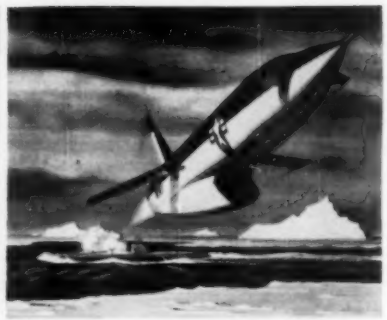
There has been some feeling that missiles will take their place and that Britain's future aircraft exports will largely be guided missile systems.

Sales Obstacle

But here the prospective sales run into a tremendous obstacle—the technically unsophisticated countries that could not operate a missile system even if it were given to them. It is one thing to sell a handful of Hunters to an oil-soaked kingdom, and another to sell an anti-aircraft missile defense system.

Britain's only prospective customers in missiles could be expected to be France and West Germany. Anybody else is either not proud enough or too poor to buy them. With U.S. Army and USAF missile units now stationed in Germany, the Americans have a big advantage in selling the later breeds of weapons to the Germans.

All this spells future troubles for Britain's aircraft exports unless a second Viscount comes along. Optimistic estimates have been quoted for the world market for a short-range jet such as



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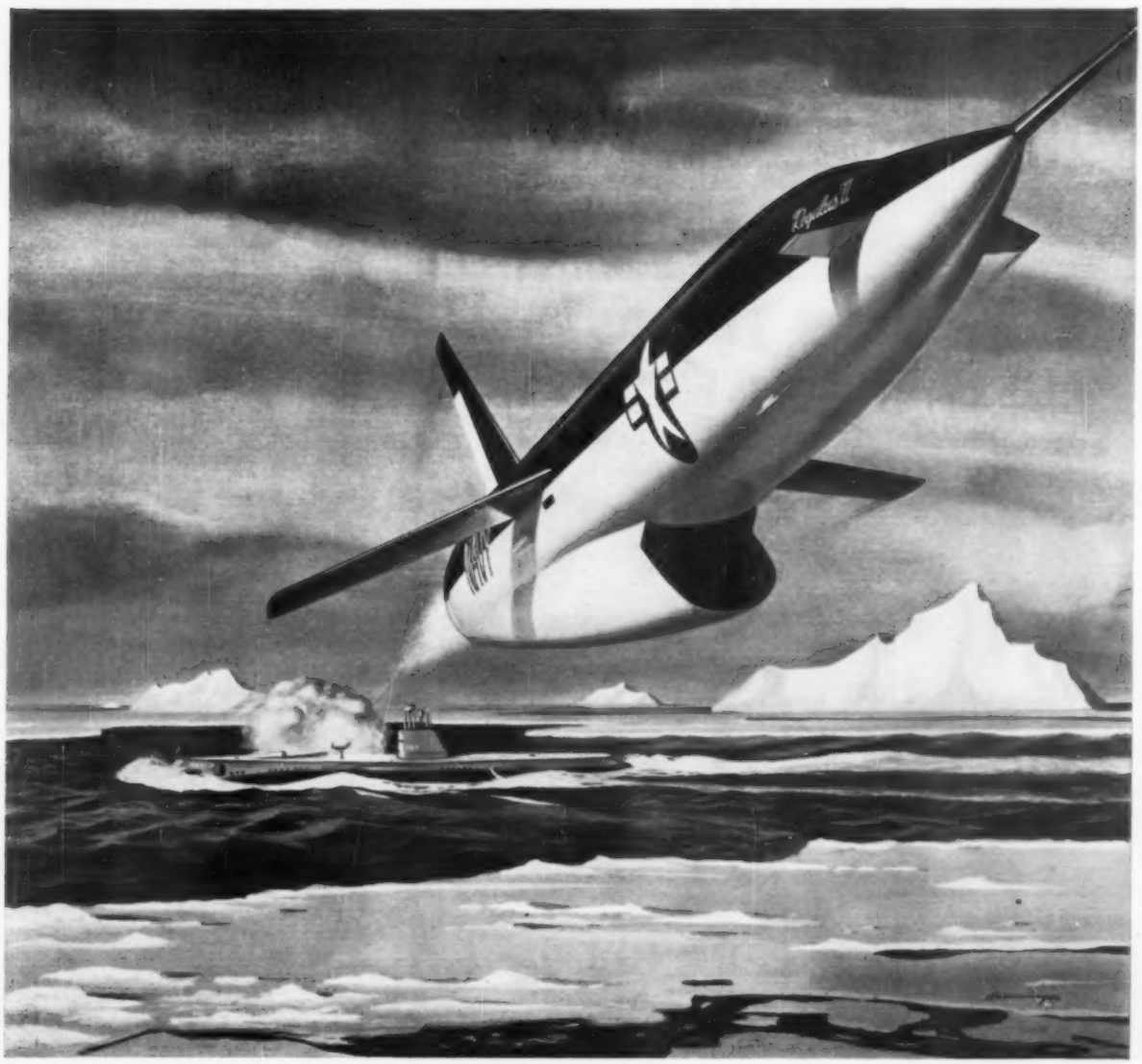

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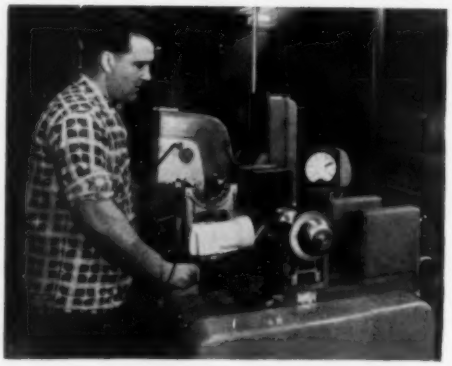

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BEA wants. Figures of up to 3,000 jet and turboprop aircraft have been mentioned and equated with Britain's share of the market.

But other observers of the international transport scene are less optimistic. Some of the continental operators want no part of short-range jets, not even for competitive reasons. These are among the "customers" for the short-range jet the British are touting.

Actually continuing delays on the short-range transport choice by BEA gave the whole affair the sound of an American soap-opera: "Will BEA be allowed to buy the aircraft of its choice? Will Hawker-Siddeley Bristol sell their airplane to the United States? Will Airco be able to finance the development alone? And what of Pan-American's interest?"

The issue was simple. BEA didn't want jets and the industry didn't particularly want to make them for BEA alone. The prospective order was for only about two dozen, nowhere near the usual breakeven point for modern transports.

But BEA was being forced into jets because of the approaching introduction of the American Boeing 707 and Douglas DC-8 types on inter-European routes.

Tough Specs

The airline worked out a tough specification. Their new jets would have to carry between 70 and 100 passengers, cruise at an honest 600 mph. at 25,000 ft., be able to get on and off a 6,000-ft. runway on a hot day and in general behave like a paragon.

Avro, Bristol, de Havilland and Vickers answered the call and submitted proposals. Vickers dropped out first, preferring to concentrate on the bird in the hand, which turned out to be the shopping order for VC-10s for BOAC. Avro, with its background in transports and big jet aircraft, dropped its Vee-tailed design and share in the facilities of the Hawker-Siddeley Group to back jointly with Bristol the latter company's Type 200 tri-jet transport. DH proposed its Model 121, later formed a second group with Hunting and Fairey, and the fight was on.

DH finally got the contract, but not before one of the longest and most frustrating delays in the history of order placing. Nub of the delay, discounting all the propaganda, was the government's reluctance to finance the development, and its insistence that private financing be the rule. Industry at first said it couldn't afford to; government's rejoinder was that if the industry consolidated, it could.

Industry's stand is that they know this, and they probably will unite in good time, but they resent being told to do so and particularly resent that

the impending order for BEA's transport should be used as a club to beat them into consolidation.

There the issue stands. The "consolidations" for BEA's contract are not the same kind of consolidations the government wants, and are more of a necessary gesture than a firm action. Nobody expects DH to take over Hunting and Fairey after the short-range jet fades into history, and nobody expects the Hawker-Siddeley Bristol combine to survive after losing the BEA order.

Thus the traditional pattern of a large number of small companies bravely flying the flag each year at Farnborough seems to remain. Outwardly things don't look too bad, even in the light of the cancellations of the year past.

The year started well enough for industry. The West German orders were announced. DH's mighty Gyron turbojet was officially rated at 20,000 lb. dry and 25,000 with afterburning. The Saunders-Roe SR. 53, precursor of the more-sophisticated SR. 177, was nearly ready to fly.

Then came the first cutbacks. The Ministry of Supply dropped its support of the Gyron less than a month after DH's proud announcement. Time ran out for the Royal Auxiliary Air Force and the Royal Naval Volunteer Reserve Air Branch; on a weekend in March, these proud defenders of Britain in the air for two wars were finally disbanded.

White Paper

The ax fell in April with the publishing of the now-famous—or infamous—Defense White Paper. There was to be no supersonic manned bomber, it said, and it was unlikely that the Royal Air Force would have a requirement for a manned fighter beyond the English Electric P.1. The forces were to be cut back, and some RAF officers and enlisted men would be "redundant"—the new and polite word for "unemployed."

You could hear the howls all over England. Industry was indignant and indicated that the whole thing was nonsense and just another example of the damned foolishness you get when the government runs things. But to a tax-burdened nation whose overall position on the list of world powers was dropping nearer the bottom, the White Paper made some sense.

The biggest complaints came from those who believed that the day of the guided missile, blithely accepted as practically here in the context of the White Paper, was in fact somewhat further off, and that Britain was going to find itself in another bind when its current fighters were obsolete and the missiles hadn't yet become operational.

There had been a similar situation in the Korean war, when Britain was unable to field a single contemporary aircraft, and relied on the Gloster Meteors to put up a valiant and losing fight against the Russian-built MiGs. That was due to the lack of research and development funds available after the war, and the ill-conceived policy of "no manned supersonic flight." Again it was probably chargeable to reducing taxes, but because of a slightly lessened tax burden in 1946 and 1947, the Royal Air Force had no modern fighters in Korea. When Hunters did enter service with Fighter Command, they were not on a par with operational aircraft in Russia or the United States.

Cutbacks

During the rest of the year, the effects of the White Paper continued to be felt.

- **Saunders-Roe SR.177** was canceled when the Ministry of Supply refused to support it further and the Germans didn't offer to buy it.
- **Bristol Orion** supercharged turboprop was mothballed by the company after the British Ministry of Supply dropped its support.
- **Hawker P.1121** ground-attack fighter was mothballed after MoS repeated its contention that there was no requirement. Plane was almost completed and due to fly early this year. Hawker-Siddeley's support dwindled to a trickle.
- **Vickers research** on a very highspeed aircraft "of unusual form" was reduced when MoS withdrew support. Vickers still is financing the project, dreamed up by their chief of research and development, Barnes Wallis.
- **Famous operational airfields** whose fighter squadrons spearheaded the epic defense of Britain in August and September 1940 were closed down or will be. Among the casualties: Biggin Hill, Croydon, Hornchurch, Tangmere.
- **Royal Air Force** announced details of its redundancies, and advised officers of certain ranks and dates of service to apply for premature release.

On the civil side, there had been delays and teething troubles with the Bristol Britannia. This four-turboprop airliner left its Filton production lines in what was thought to be "ship-shape and Bristol fashion"; but it also had a built-in ice-making plant. It flew, it made ice and the engines choked in swallowing it. Sometimes the engines surged, sometimes they just stopped.

Bristol, the Royal Aircraft Establishment and other agencies leaped into action, tried fix after fix to make the Proteus engines operable in icing conditions. After several temporary fixes they now believe the problem is licked.

Once fixed, the Britannias racked up an amazing series of long-distance high-speed runs from New York to Israel, across the North Atlantic, and to South Africa. Passengers loved its comfort,

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and the airlines loved its utilization—about 8 hr./day. The bad start seemed to have been overcome and the Bristol Britannia was well along on its way to being a moneymaker for the airlines using the big plane.

Vickers Viscounts continued to be built and sold in a quiet way. A local-service version was announced early this year.

Handley-Page's civil project, the four-engined Herald, was not going too well but was going to be joined by a two-Dart version which the company hoped would do better. The Alvis-powered job was on flight status and had been for some time, but there were no great orders for the plane.

The little Aviation Traders Accountant, a feeder-liner design powered by a pair of the Rolls-Royce Darts, flew in mid-year and at Farnborough. Early this year it flew for the last time, and since then it was mothballed because there were no prospective manufacturers or buyers.

Fairey's Rotodyne, a combination of helicopter-autogyro-airplane, provided one of the technical highlights of the year when it was rolled out and flew almost dead on the schedule set for it several years before. This aircraft has excited much interest in the United States, and assuming that the flight tests go well and estimated operational costs turn out to be realistic, the company could have a potential moneymaker in this large turbine-powered convertiplane.

Militarily, there were changes in the Royal Air Force. First Hunter squadrons of Fighter Command were disbanded and fields that could not meet minimum standards or were not placed well for air defense were closed down or reduced to a caretaker basis. The command's major task is the protection of Bomber Command bases. No Hunter 6 outfits have been axed yet, and it is not likely that will be done until Fighter Command is up to full strength with the Gloster Javelins. The English Electric P.1 will be the Javelin's successor, and will be first-line equipment for another decade. First short-range ground-to-air missiles of British design are to become operational weapons this year.

Bomber Command

Bomber Command activated its first Avro Vulcan squadron during the year. The four-jet delta-winged craft were enthusiastically received and have been well-liked in the limited time they have spent in service.

First deliveries of the Handley Page Victor are being made, and announcement of the first squadron is expected momentarily. Bomber Command is now being armed with megaton thermonuclear weapons from British production facilities.

Transport Command quietly racks up time in its Comet 2s, the only jet-propelled transports in military service. Bristol Britannias have been ordered and re-ordered this year, but for some time to come the Command will be making-do with inadequate numbers and types of airplanes.

New Navy Planes

Royal Navy's Fleet Air Arm still has to get its first squadron of sweptwing fighters—whatever they may turn out to be—and meantime is operating straight-winged Armstrong-Whitworth Sea Hawks. First squadron of the Vickers Scimitar strike fighter has formed at a land base, but is not yet ready for a sea tour. Blackburn's NA.39 attack plane is due to fly this year. The NA.39 is being considered for adoption by the RAF. DH Sea Vixens, the descendant of the DH-110, are operational and carrier-qualified with the Fleet. But a blow to Fleet futures was the cancellation of the SR.177, of which 100 were on order for the Royal Navy.

RAF Strength

Total strength of the Royal Air Force at the end of this year is expected to be 182,000. Future authorized strength will be reduced to about 135,000 by the end of 1962, at which time the total of all three British military services is expected to be down to 375,000 from today's figure of about 606,000.

The report on defense issued two weeks ago says that pilot recruiting is "almost sufficient," but for other classes of aircrew it will have to be increased. If the current rate of recruiting continues, the 1962 strength will only be about 120,000.

Manpower figures, according to the defense report, "do not include boys, women, Gurkhas, colonial troops or locally enlisted personnel."

So the balance sheet for the year shows four new planes flown of which two are rotary-wing: Saunders-Roe SR.53, Aviation Traders Accountant, Westland Wessex helicopter and Fairey Rotodyne. Two of these—the SR.53 and the Accountant—are to go no further.

Two engines were dropped from the MoS support list: DH Gyron and Bristol Orion. The net balance is not a favorable one.

Several years ago, this magazine said the danger was not that Britain was at that time producing obsolescent aircraft, but that unless something were done quickly, she would never again produce any other kind.

There has been no reason to change that opinion since, and much time has been lost.

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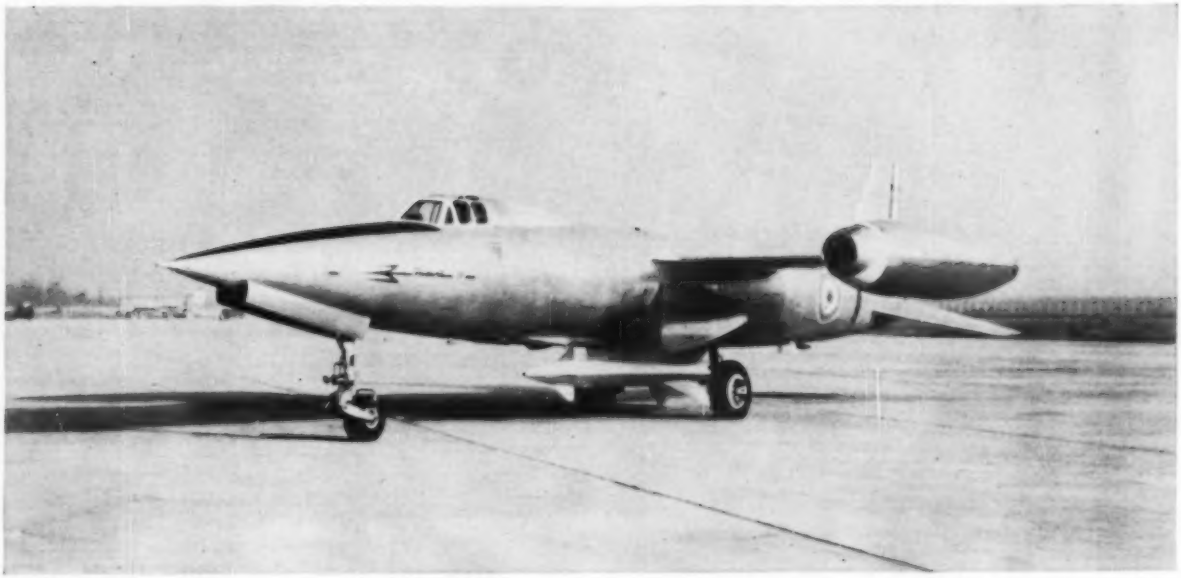


SUD TRIDENT II

Budget Cuts Weaken French Industry

By Robert Farrell

Paris—Last year was a period of glory and despair for the French aircraft industry.

The glory stemmed from the dazzling array of French achievements displayed during the Paris Air Show in June. An admiring aviation world heaped praise on the French industry for its lightweight interceptors and fighters, its wide range of powerplants, its VTOL Flying Atar, and its general all-around engineering know-how reflected in its aircraft, helicopter and engine designs.

As AVIATION WEEK wrote at the time: "Technical leadership of western Europe's aircraft industry is now both the property and the responsibility of the French."

Yet not many months after the June Air Show the industry was rocked by severe budget reductions. Result has been production stretch-outs as well as complete abandonment of several advanced prototype aircraft. It now appears that unless the French industry finds additional export markets, or unless U.S. or other foreign funds of the "off-shore" nature are spent in France, then the industry's future will lose much of its promise.

Gloomy Outlook

With the 1958 calendar year military budget already approved, though not as yet revealed in detail, this is the way the picture looks at present:

• **Leduc O.22 ramjet project** has been virtually brought to a complete halt by combined budget cuts and December ground accident which destroyed major portion of single flying prototype. Air Ministry has more or less withdrawn its financial support from the Leduc project despite fact that second prototype is nearly completed.

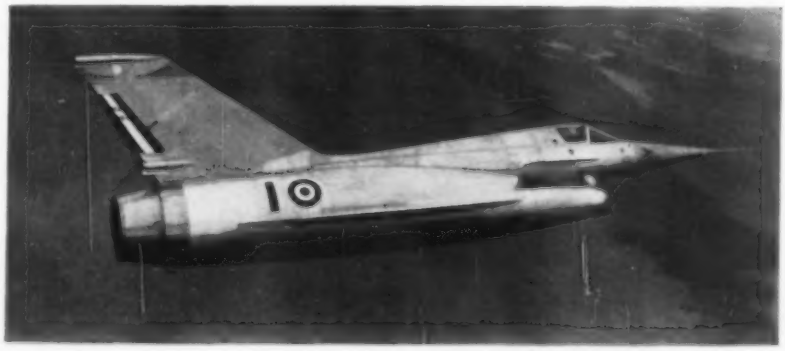
• **Super-Vautour jet bomber** with supersonic bombing capability now is completely eliminated from Air Force plans. Twin-jet project of Sud Aviation was nearing prototype stage.

• **Trident rocket-turbojet interceptor** project has been sharply curtailed. Ten preproduction orders for the Sud Aviation aircraft have been sliced in half. Company expected to use all 10 preseries Tridents for perfecting piloted production version. Now Sud must use the half-dozen it has to cover a design program which goes all the way to the pilotless Trident version.

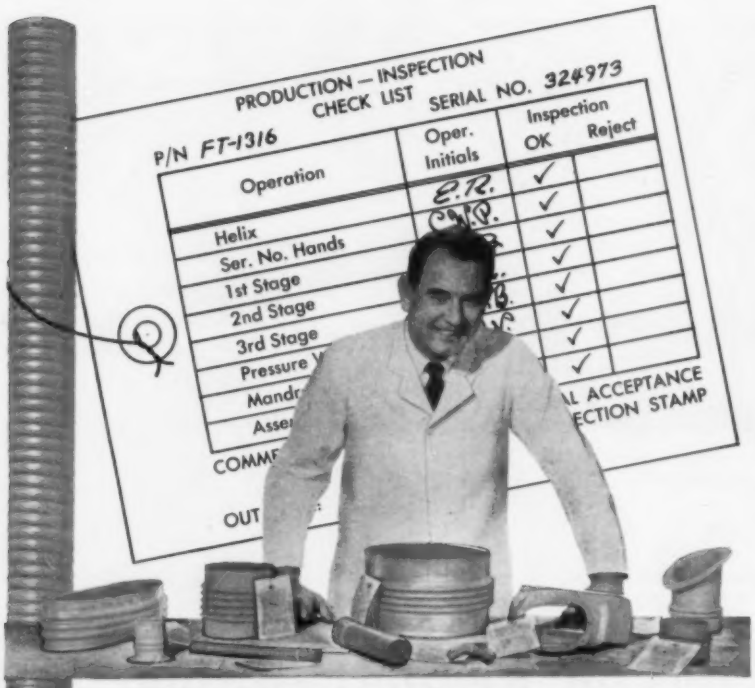
• **Breguet "Sahara" four-engine** transport, modified version of its Deux Pont cargo aircraft, has been all but dropped by military.

Order for 15 aircraft was completely canceled, but after company argued that four aircraft were just about completed, military agreed to consider taking delivery of the four.

• **SIPA 1100 twin-engine "police plane"** and Morane-Saulnier's "Epervier," a turboprop colonial ground-support aircraft, both were hit by budget squeeze just as prototypes are being readied for initial flights. SIPA 1100 is powered by two Pratt & Whitney R1340s rated at 610 hp. Epervier is powered by Turbo-



NORD 1500 GRIFFON II



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• FRANCE

meca Bastan 750 hp. turboprop. The two projects probably will be dropped from French military plans.

• **Current budget** reduction may stretch out, and in some cases cancel out, further production of Nord's Noratlas twin-engine transport; Sud Aviation's twin-jet Vautour, and perhaps its Djinn helicopter; Dassault's Super-Mystere fighter-interceptor, just as this supersonic airplane is reaching FAF squadrons; and, perhaps most important of all, may slow down Snecma's development of its VTOL Flying Atar project.

Industry officials point out that all this franc paring would have some merit if it reflected some well-conceived air policy on the part of the French Air Ministry. It would be unjust to assert the Air Ministry lacks an air power concept, though it is often hard for observers to catch hold of it. This is partially explained by fact that the Air Ministry is politically weak and often accepts reductions from the Defense Ministry which, in the country of Napoleon and Foch, traditionally has been dominated by Army.

French Air Force front-line strength during 1957 remained stable and this year may even decline. How much a decline won't be known until detailed figures of the 1958 defense budget are released. It is understood the Air Force '58 budget is below the $817 million voted in 1957 with less money earmarked to pay production bills and somewhat more to pay research costs, mainly in missile work.

French defense department officials are determined to push development of nuclear weapons, even if this means foregoing a much-needed re-equipment program for FAF. Air Ministry officials, for some reason, seem to be sitting back while Army moves into the missile picture. Army did the same thing in light-aircraft and helicopters, though FAF now seems aware of this particular invasion of its rights.

Major Mission

One imposed difficulty on FAF planning is that its major mission today, as it has been for the last two years, is not supersonic NATO missions but rather support of French Army operations in the Algerian war.

Thus, the sharpest gain in FAF strength over the past two years has been in helicopters and surplus American "fighters" like the North American T-6 and bombers like the Douglas B-26. Much of the present FAF combat strength of 40 squadrons, way below planned goals, is made up of outmoded French equipment or MDAP Republic F-84Fs and RF-84Fs. One all-weather squadron has been set up equipped with Sud Aviation Vautours.

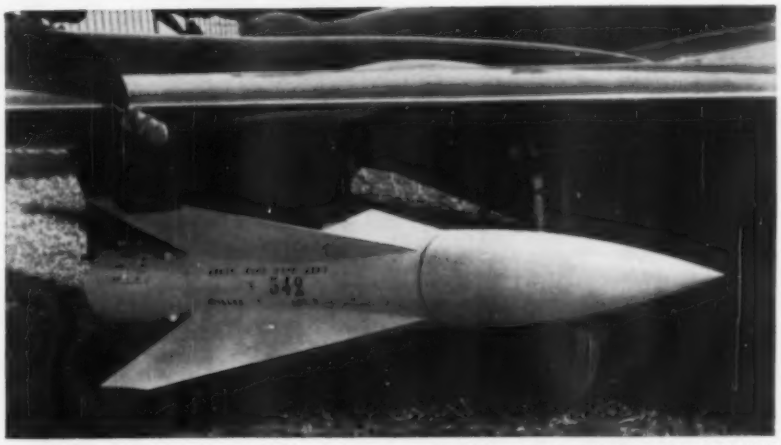
If FAF's current fighting ability seems unimpressive, its future combat

DASSAULT ETENDARD IV

strength looks considerably better. During late 1959 and 1960 FAF will be taking delivery of Dassault Mirage III delta wing Mach 2 interceptors powered by Snecma Atar 9 afterburning engines developing thrusts of 13,200 lb. Last summer Air Ministry ordered ten preproduction models of the Mirage III plus tooling which indicates a follow-on production for several hundred of the aircraft.

Of course, future budget difficulties may hamper this program as it has the Super-Mystere order.

Mirage III, first flown in November, 1956, is designed to carry out high altitude interceptor missions as well as tactical support tasks. Interceptor version probably would be equipped with SEPR 3,300 lb. thrust rocket unit in addition to Atar turbojet. Dassault is also working up a Mirage trainer version. First of the 10 preproduction



NORD 5103 AIR-TO-AIR MISSILE

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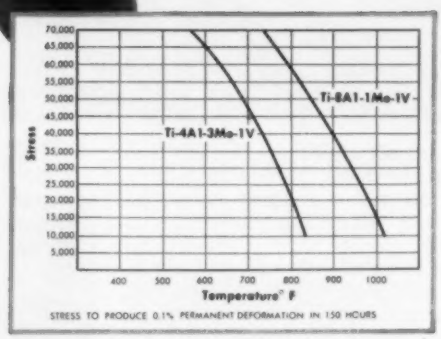

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Mirage IIIs should fly this spring.

FAF's postwar ambition of re-instituting a bomber command probably won't be realized until the two-place Mirage IV appears on the scene. This supersonic aircraft, about which Air Ministry will say nothing as yet, is called by those who have seen the mock-up, the "French B-58." At least one prototype is being built. With the Super Vautour project eliminated, work on the delta wing Mirage IV may move ahead at a faster pace.

FAF's original plan to launch its first postwar bomber command with Vautours seems out of the question, considering the production cut-backs. Some 35 Vautours have been delivered to FAF, mostly in all-weather version rather than bomber version. Air Ministry officials, realizing that a French bomber command made up of subsonic Vautours is no longer a grandiose ambition, are quietly turning over a number of their Vautours on order to the Israeli Air Force.

Future Punch

To sum up, the future punch of FAF, assuming budget credits are maintained at present levels, appears to be based on Dassault's Mirage III interceptor-fighter bomber and Dassault's Mirage IV supersonic bomber.

FAF presently has no orders in for lightweight strike fighters, perhaps hoping that NATO competition in this field will handle the problem both technically and financially. Dassault Etendard VI and Breguet Taon, powered by either Bristol Orpheus 3 or 12 turbojets, represent main French contribution to this field.

For training purposes FAF uses Fouga Magisters, of which over 100 have been delivered to the French air training center at Salon.

FAF airlift capability will rely mainly on Noratlas and DC-3 aircraft, plus the four Breguet Saharas which FAF may accept if the money can be found. Air Ministry has disclosed no jet or turboprop transport projects.

Only experimental aircraft which still appears to have solid Air Ministry backing is Nord's Griffon 02, a combined ramjet-turbojet aircraft with delta wing and canard layout. Craft has flown at Mach 1.8 in climb, is now being modified for test flights beyond Mach 2. Present prototype first flew in January of last year, though Griffon project dates back several years. With the Leduc O22 ramjet project eliminated, the Griffon 02, which owes much to the concept of Rene Leduc, has the French ramjet field all to itself.

French naval air arm, like FAF, is working under severe budget restrictions. Whether Navy will ever launch its first modern aircraft carrier, the Clemenceau, still remains an unan

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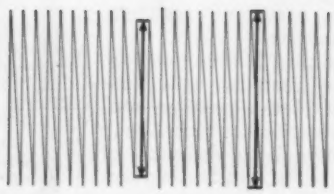
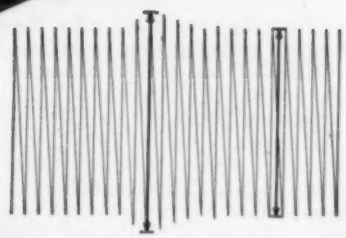


With 100 percent load ON, voltage dips to 100.5V; recovers completely in .041 seconds.



With 100 percent load OFF, voltage goes up to 134V; recovers completely in .066 seconds.

SUMMARY OF RECOVERY TIME TESTS
(At 8000 RPM generator speed)

% Load	Regulator Ambient	Recovery Time		Maximum (or Minimum) voltage during transient	
		Load On	Load Off		
100	Room	.044 sec.	.053 sec.	103.2	133.5
100	120°C	.072 sec.	.071 sec.	101.0	138.0
100	−55°C	.047 sec.	.077 sec.	101.0	132.0
150	Room	.037 sec.	.057 sec.	95.5	144.0
150	120°C	.052 sec.	.068 sec.	89.5	147.0
150	−55°C	.049 sec.	.073 sec.	93.5	144.0
200	Room	.044 sec.	.065 sec.	87.0	152.0
200	120°C	.074 sec.	.072 sec.	80.0	153.0
200	−55°C	.045 sec.	.071 sec.	85.5	154

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100%.....± 1%
150%.....± 1%
200%.....±2.5%

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swered question. Shortage of credits also is slowing up Navy's project for a small carrier designed solely for helicopter use.

Navy, however, has kept its ambition in check on aircraft and so far has been able to maintain its order for 100 Breguet 1050 Alize antisub aircraft. Powered by a Rolls-Royce Dart 7 developing 2,105 eshp., Alize carries a crew of three. First production version should fly this spring; five preproduction aircraft already have been delivered.

Navy also has ordered 10 preproduction carrier version of Dassault Etendard IV, to be powered by Snecma Atar 8 developing some 9,500 lb. thrust. Follow-on production order for the Etendard reportedly will amount to 100.

With the Alize and the Etendard, French Navy will for the first time be operating French-designed aircraft. Present equipment is mainly U. S. and British built or designed aircraft.

Missile Picture

On missiles, the French make few claims. It is admitted that no anti-aircraft or tactical missile has reached production stage. It is known that Sud Aviation, which operates a missile division at Cannes, has sent missions to England to look over the English Electric Thunderbird anti-aircraft missile. If the Air Ministry decides in favor of the Thunderbird, which doesn't seem likely at the moment, it would be built in France by Sud Aviation.

Apparently the French Parca ground-to-air missile, on which some $28 million reportedly was spent in development, is now definitely abandoned.

There are reports that French air squadrons are receiving a limited number of Nord 5103 air-to-air missiles. If so, this is the first French air-to-air missile to go operational. Nord 5103 weighs 297 lb., is about 8½ ft. long. Guidance is by radio link from the attacking aircraft. French have fired missiles from under belly of Nord delta-wing Gerfaut experimental interceptor at supersonic speeds.

Nord 5103 production order may mean French have dropped the R 510 air-to-air missile developed by Matra, a company now controlled by Breguet. The R 510 was known to be a Mach 2 missile, weighing about 375 lb., and has been seen fitted on Dassault Super-Mysteres.

Nord continues to enjoy considerable success with its anti-tank SS-10 and SS-11 missiles which are wire-guided to the target. Company has registered both domestic and foreign orders, including sales to U. S. Army. SS-10 and SS-11 can be mounted on a jeep or other type ground vehicle, have been fired from Alouette helicopter.

French industry would like to get together with other European NATO nations, preferably continental NATO members, on an IRBM program. Certain studies along this line, stemming from resolutions taken at the December NATO summit meeting, are underway with Sud Aviation playing a leading role.

Recent arms agreement signed in Bonn between French, German and Italian defense ministers holds out promise that these three nations may eventually get together on the development and eventual production of ballistic missiles. French and German scientists already have been cooperating in joint studies both in Europe and at the French missile test center at Colomb-Bechar, in the Sahara region.

With a shrinking domestic market, evidenced by budget cuts, industry officials continue to drive after exports. Industry export sales at the end of 1957 had climbed to over 105 billion francs. At the beginning of 1956, when the French first began to export in earnest, foreign sales totaled less than 10 billion francs.

Aircraft Sales

Sud Aviation, the nation's largest company, had a good year with its Caravelle medium-range jetliner and with its Djinn and Alouette helicopters. During the year Sud sold six

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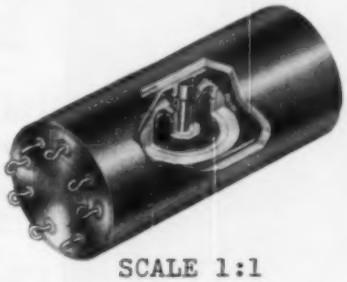

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Unit	Date Started	Continuous Running Time To Date
a.) At 200°F Ambient Temperature		
Gimbal #1417	30 Sept 57	3048 hours
Gimbal #1435	30 Sept 57	3048 hours
Gimbal #1468	30 Sept 57	3052 hours
Gimbal #1477	30 Sept 57	3052 hours
b.) At 150°F Ambient Temperature		
Gimbal #1256	3 Jul 57	4014 hours
Gimbal #1262	3 Jul 57	4014 hours
Gimbal #1361	2 Aug 57	3623 hours
Gimbal #1445	30 Oct 57	2360 hours
Gimbal #1472	30 Oct 57	2360 hours
Gimbal #1546	1 Nov 57	2306 hours
Gimbal #1605	1 Nov 57	2306 hours

Military Products Department

AMERICAN-Standard
DETROIT CONTROLS DIVISION
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Vertol 44 flies 19 passengers or 2 tons of cargo to offshore rigs

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Tandem rotor design enhances safe operation from small platforms even under crosswind conditions and in gusts. Note whitecaps whipped up by 30-knot wind.

VERTOL Aircraft Corporation

MORTON, PENNSYLVANIA

Caravelles to SAS, two to Varig Airlines of Brazil, and finally another three to Finnair. These orders come on top of an order for 12 placed by Air France. Very likely the French carrier this year will pick up its option on another 12 Caravelles.

Georges Hereil, Sud Aviation president, still is optimistic about sales prospects for the Caravelle in the United States. So far the Varig order is all the company has to show for its extensive tour of the Americas last year. Hereil expects to lead personally a renewed sales effort in the U. S. this spring.

Caravelle Output

Caravelle production will reach monthly rate of four by early 1960, and could double if need be without much extra tooling. At least 15 aircraft are expected to be built next year. First Air France production Caravelle should fly this spring, with first two deliveries slated for late fall.

Sud Aviation has delivered over 100 Alouette helicopters and over 60 Djinn helicopters to national and foreign customers. The two helicopters have been sold in small quantities to 14 different nations. More important, Sud Aviation late in the year sold the Alouette II manufacturing license to Republic Aircraft.

During 1957 both the Alouette and Djinn 'copters went into combat service in Algeria. Performance data so far is highly favorable.

On heavy helicopters, Sud presently is working up a prototype called the Super-Alouette which will be powered by three Turbomeca turbines and will boast passenger load of 28. Super-Alouette probably will fly in 1959. Meantime, Sud has begun to exercise its manufacturing license for the Sikorsky S-58. First Sud-assembled S-58 flew in May. Company gradually will evolve from partial assembly work into full-scale manufacture of the heavy helicopter.

Breguet Efforts

Breguet also is seeking to free itself from money-short French military by developing foreign markets. Company signed agreement with U. S. outfit called TriFrance under which sales of Breguet Deux Pont cargo aircraft are being pushed in the Americas. Breguet also signed technical agreement with Piasecki Aircraft and Dornier of Germany.

Breguet's STOL project, the four-engine 940 Intergral, will fly this spring. Experimental transport uses no tilting wing or rotor mechanism, instead gains lift by deflecting induced airflow over wings into downward thrust by use of double slotted flaps. Entire 58 ft. wing is in wash of propellers. Financed in

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A typical head rest installation showing the reel, manual reset lever and cable.

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part by U.S. military funds, the Intergral is powered by four Turbomeca Turbo engines rated at 400 eshp. Larger version, the 941, will be twice the size of the experimental 940 and will be powered by four 1,000 eshp. turboprops engines, probably General Electric T58s.

Commercial Jets

In addition to military contracts, Dassault, for the first time since the war, is developing a civilian aircraft. Toward the end of this year company will fly a 550 mph., nine-passenger jet liaison aircraft, the Mediterrance, powered by two Dassault R-7 turbojets podded under sweptback wings. Dassault hopes to cash in on the growing demand among French business concerns for private fast transportation between France and French African territories.

Morane-Saulnier registered its first civilian order for its four-place executive jet aircraft, the 760 Paris, early last year with a sale to the Shah of Iran. Company has order for 50 from Argentine government, with most of the aircraft to be assembled in South America. First Paris sold in the U.S. went last December to chief executive of Timken Roller Bearing Co. Beech Aircraft Corp. is handling North American sales of the 410 mph. aircraft. Powerplant is two 880 lb. thrust Turbomeca Marbore turbojets. Beech holds manufacturing as well as sales rights.

Fouga Licenses

Fouga Magister jet trainer manufacturing license was sold during the year to West Germany and Israel. Also during 1957, Henry Potez, aviation pioneer and head of French engine and parts firm which bears his name, bought control of Fouga. Fouga shares formerly were jointly owned by five French aviation companies. Company expects to sell additional Magister manufacturing rights to Belgium and Holland, as well as six Magisters to Austrian Air Force for test flight program. FAF has ordered over 100 Magisters as has the West German Luftwaffe.

French Navy has ordered 30 Magisters equipped for carrier landings.

Biggest achievement during 1957 in the engine field was the flight test program carried out by Snecma's C400 P2 Flying Atar VTOL project. If the funds are forthcoming, Snecma probably will carry out its plans to incorporate the Flying Atar into a coleopter arrangement. Snecma holds European rights on the von Zborowski patents. Nord is also developing a delta-wing VTOL fuselage which could use the Flying Atar as powerplant.

Final decision as to which route the Snecma project will take probably will be made this year.

A CONCEPT OF SCIENCE

Five years ago, The Martin Company conceived a unique undertaking in the field of pure science.

It grew out of a belief that our own and our country's resources in creative scientific research must be greatly enlarged and cultivated.

We believed that the country—and the Company—that concentrates on short-range material achievements, without a deep concern for the creative source of tomorrow's even greater achievements, will have no tomorrow.

It is now three years since that belief motivated management's action with the foundation of a program in pure scientific research. Known as the Research Institute of Advanced Study, RIAS is now a substantial organization staffed by scientists who are working in many fields, including theoretical physics, biochemistry, metallurgy and mathematics, without short-range product or applied research requirements.

Today, the increasing appeals to industry and the nation for accelerated activities in basic research give the RIAS story a special significance. For creative research in pure science is the true life source of our technological security—the "seed bed" from which our national strength shall continue to grow.

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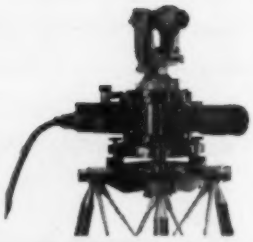
New P-E missile theodolites automatically align inertial guidance systems to within a few seconds of arc.

A new family of missile auto-theodolites has been developed by Perkin-Elmer to align inertial guidance systems with unprecedented accuracy. These theodolites are now operational at a number of missile sites and are being used in the production, testing and alignment of stable platforms.

P-E auto-theodolites monitor and automatically correct guidance equipment to within ±2 seconds of arc under day or night tactical conditions. They are available in short, medium and long-range instruments which operate from distances up to 1,500 feet. Although these auto-theodolites were developed for missile work, they are readily adaptable to a variety of non-military applications requiring highly accurate angular data.

These instruments are examples of Perkin-Elmer's ability to combine precision optics with electronic and mechanical systems. For regular information on Perkin-Elmer's design, engineering and production facilities, ask to receive OPTICS PLUS, our new quarterly publication. Write us at 770 Main Avenue, Norwalk, Conn.



Perkin-Elmer Azimuth Alignment Auto-theodolites. **Short Range** — working distance, 0 - 100 feet; **Intermediate Range** — working distance, 0 - 800 feet; **Long Range** — working distance, 200 - 1,500 feet (discriminates sway from rotational movement and automatically compensates for both).

ENGINEERING AND OPTICAL DIVISION

Perkin-Elmer *Corporation*

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DORNIER DO-27 production in Friedrichshafen.

Production Vital to Progress Of German Aircraft Industry

Biggest problem facing both the German Luftwaffe and the aircraft industry is making up for 12 barren years.

The Luftwaffe must decide on the quantity and type of its interceptor force in order to make a positive contribution to NATO defense systems in the next few years.

The industry must manufacture under license, do subcontracting and in general scratch to stay alive until it has matured again to the point where it can stand on its own feet and produce its own designs.

A delay is expected while the NATO member nations wait for the outcome of the military conference scheduled to take place this month. Purpose of the conference is to plan "all necessary reforms and modifications in the fields of strategy and armaments."

It is likely that Germany's position will not be clarified until after this month's meeting and that the air force's decision will be made then after long delays and several postponements.

Disagreement among defense experts in Bonn on the relative role of aircraft and interceptor missiles will probably lead to the German Defense Ministry order being cut to half the original best estimate of 300 airplanes.

Biggest need for the growing German aircraft industry is a solid and large production order. The industry's share of a NATO order for a lightweight strike fighter could be appreciable if the fighter were ordered in such quantity that it could not be produced in reasonable time by its parent firm working with associated groups elsewhere in NATO.

But the big question is whether or not the Fiat G.91, now recommended as the NATO lightweight fighter, will be ordered in quantity enough to justify splitting its production more than two or three ways.

Before the word of Fiat's success got out, there had been a mass of cross-licensing agreements in Europe in anticipation that one plane or the other would be produced.

Typical of these was an agreement between Dornier-Werke G.m.b.H. and Breguet by which Breguet would build the DO-27 and Dornier the Taon. The first part of the agreement will be signed soon, whereas the proposed production of the Taon by Dornier seems likely to be dropped in view of the NATO selection of the G.91.

Dornier Production

For the German aviation industry as a whole, the DO-27, of Dornier's own design, is an important development symbolic of the industry's determination to regain its onetime prominent position. The DO-27 is the first and only post-war German aircraft to be ordered in large quantity. It is a relatively simple 6-seater piston-engined STOL aircraft with outstanding handling and low speed qualities. Dornier is concentrating on its development as a feeder aircraft for major air routes and for business flying.

At present the firm's Munich-Neuaubing works turns out about 15 to 20 a month. So far 100 have been produced of a total of 428 ordered last

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General Electric Announces New Electric Power Package

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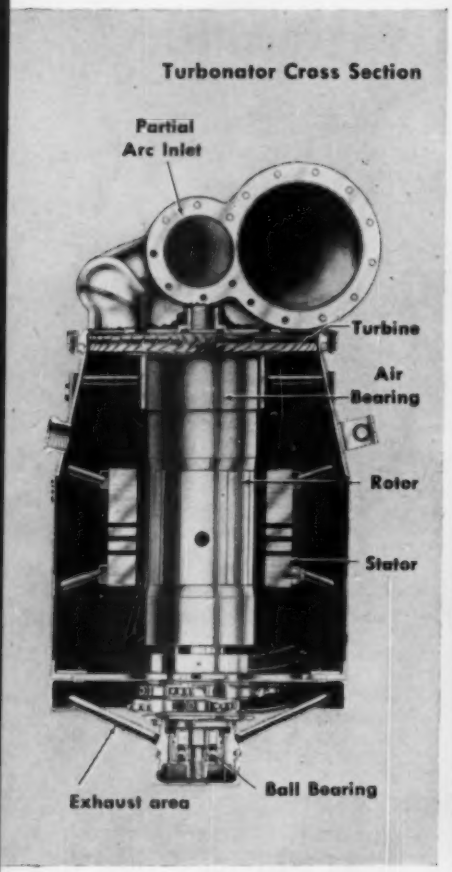

New, Self-cooling electric power generating system increases aircraft and missile performance THREE WAYS...

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3. Air-condition generators at high Mach numbers—Utilizing the turbonator principle, it is possible to increase high-Mach ambient performance of *any* generator. For example, under full load, Mach 3, 80,000-ft operating conditions, winding temperature of the turbonator is *140 F below* ambient, *300 F below* temperatures reached by conventional systems.

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year by the West German Defense Ministry for the Luftwaffe for delivery by the end of 1959. A further batch of 50 will be ready for delivery this month.

But Dornier is not interested in producing DO-27s chiefly for military purposes. Dipl.-Ing. Claude Dornier, Jr. believes there is a vast civil market for the DO-27 type of aircraft once business flying is established in Europe and is no longer considered a luxury. The firm is going ahead with the promotion of the DO-27 for this purpose while concentrating on STOL and VTOL aircraft development. Dornier employs about 1,200. The firm is a private enterprise of the Dornier family.

Big Three

Of the three big aircraft manufacturers in South Germany—Dornier, Messerschmitt and Heinkel—Dornier was the first to make a start with its own postwar designs and thus to become independent of foreign license agreements which are the mainstay of nearly all German aircraft manufacturers today. Until ratification of the Paris Agreement two years ago, Dornier could not start production in Germany.

During the interim it established a new firm called Oficinas Tecnicas Dornier in Madrid where, under the leadership of Prof. Dr.-Ing. Claude Dornier, a small team of engineers designed and produced the prototype DO-25 which was the forerunner of the DO-27, the prototype of which was produced in 1953, also in Madrid. After the Paris Agreement was signed in 1955, Professor Dornier and his three sons transferred further development of the DO-27 to Friedrichshafen and Munich in Germany.

Administration and technical management of the entire concern are in the hands of Prof. C. H. Dornier and his sons, Claudius, Peter and Silvius.

Messerschmitt Magisters

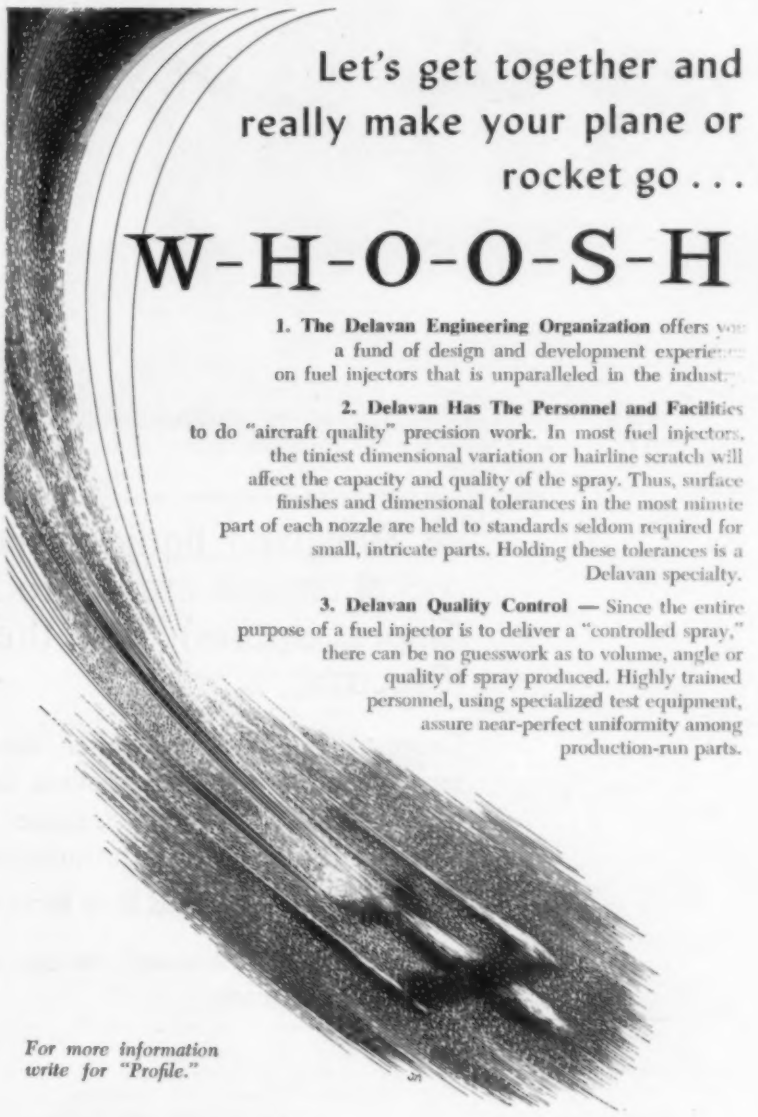
Messerschmitt A. G. is about half Dornier's size with a labor force of approximately 655. Administration and production are at Augsburg. Planning and development under Prof. Dr.-Ing. Willy Messerschmitt was transferred from Augsburg last year to Munich. The firm works closely together with Ernst Heinkel Flugzeugbau G.m.b.H. and about a year ago the two firms signed an agreement for cooperation in the production of a series of 210 French-designed Fouga Magister trainers. Messerschmitt makes the fuselage of this airplane, Heinkel the wings and control surfaces. It will take another three years to complete this order.

Since 1951 Prof. Messerschmitt, who is also chief designer of the firm, acts as consultant together with a small team of his engineers to Hispano Aviacion in Seville. Under Prof. Messerschmitt's leadership the Messerschmitt Me 109 fighter was produced in Spain as the HA 1112. Three piston-engined trainers, the HA 100, were also produced and developed into a later version with jet engines called the Me 200 (or HA 200) now going into production for the Spanish Air Force. A first batch of 100 are at present under construction.

The next step, still under Prof. Messerschmitt's leadership, will be the development of a supersonic fighter

Luftwaffe Strength Figures

Pilots, all stages from training to operations	1,200
Technical personnel, mechanics, etc.	3,900
Communications	3,500
Intelligence	600
General service	1,160
Total strength including flak battalions, troops, etc.	32,000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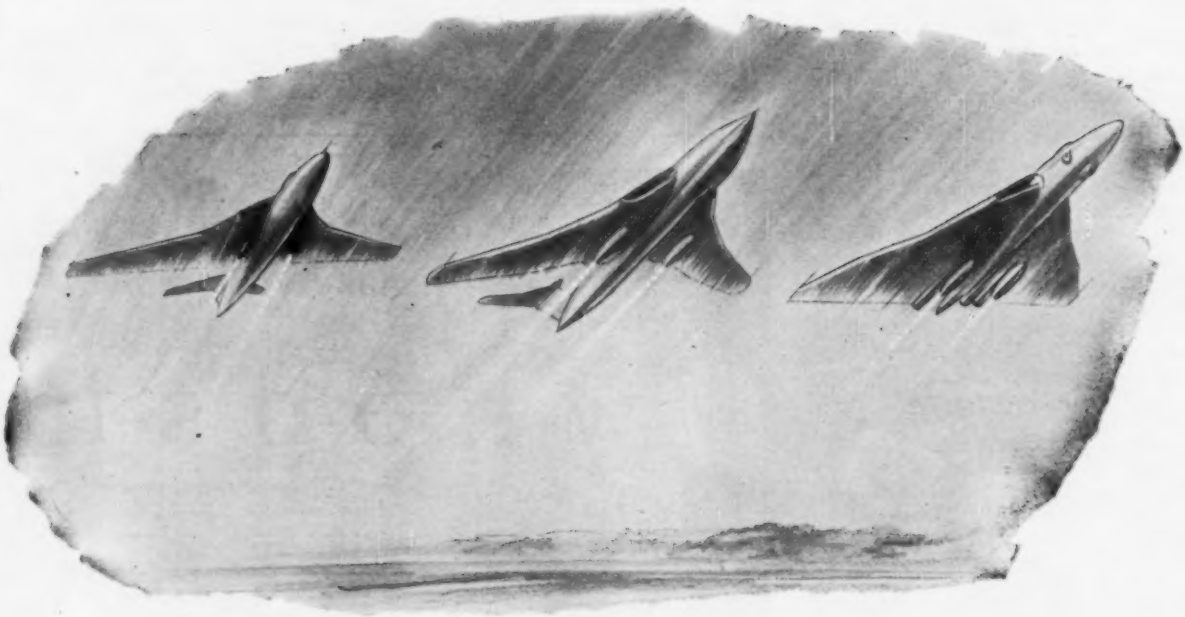

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Operational flexibility is thus increased manyfold.

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designated HA 300 by Hispano Aviacion.

Messerschmitt and Heinkel participated jointly in the competition for an interceptor design for the new German Luftwaffe, but Messerschmitt thinks it is more likely to obtain first another order to build a foreign machine under license, for example, the Dassault Mirage, or the Lockheed F-104 Starfighter or Grumman Tiger.

A license agreement in principle has lately been reached between Messerschmitt A.G., Augsburg, and Fiat of Turin for the production of the G.91.

Following an earlier visit of West German Defense Minister Strauss, a German test pilot team evaluated the G.91 in nine flights at Turin in the middle of January this year and the Messerschmitt-Fiat agreement now depends on the team's recommendation to purchase this strike fighter.

Magister Components

Ernst Heinkel Flugzeugbau G.m.b.H., Speyer a/Rhein, where production of Fouga Magister components is done, together with Messerschmitt A.G., Augsburg, constitute the so-called Flugzeug-Union-Süd G.m.b.H. with headquarters at Munich. Sole purpose of the Flugzeug-Union-Süd is to allocate any orders received according to capacity.

Heinkel has about 1,800 workers including 90 engaged in development and research at Stuttgart-Zuffenhausen. The figure of 1,800 also includes the labor force working on the production of bicycles, scooters and motor vehicle engines at Karlsruhe.

Heinkel says that at the moment it is capable of producing 7 to 8 planes a month but that the layout of its workshop would enable it to increase this figure four or five times with a minimum of disturbance of existing production facilities and very little additional expense.

The firm aims at participating actively again in the development of modern aircraft and believes it is well prepared for this task with its highly skilled technicians and engineers.

Missile Renaissance

The only firm in Germany today working on guided missiles is Bölkow-Entwicklungen KG., Stuttgart. It started operations in 1955 with a design office for automation at Degerloch, a suburb of Stuttgart, and a workshop at Augsburg.

Head of the company and brains of the enterprise is Dipl.-Ing. Ludwig Bölkow, a former employe of Heinkel. During the war years he was a designer with Messerschmitt A.G.

Bölkow-Entwicklungen K.G. carries out its research and development at Stuttgart where it employs 150 engi-

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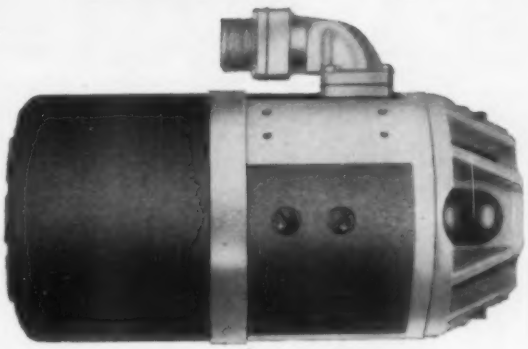

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The fellow right behind you, what about him? He's another good friend. Just help make him more capable of capturing your present spot . . . see, now he's pushing you!

How can you serve yourself better than you ever have before? By upgrading your own job performance. By learning all you can about other functions of your company's business. By putting today's problems together with tomorrow's promises . . . and becoming more and more knowing about both, right here in the high-utility pages of this one specialized publication.

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neers. The firm's workshops, where prototypes and test units are made, are at Nabern/Teck near Stuttgart and at Augsburg with a total labor force of 200.

The company is financed chiefly by Hamburg banker Wolfgang Essen. Registered capital is DM 700,000, but actual working capital is now about DM 1,000,000 ($250,000).

Since 1955 the firm has been developing a wire-guided anti-tank rocket called the Cobra I. It weighs only 18.7 lbs., has taken two years to develop and is still undergoing tests. Two Swiss firms, the Contraves A.G. and the Werkzeugmaschinenfabrik Oerlikon Bührle & Co., both of Zurich, worked in conjunction with Bölkow on production and subsequent testing of this rocket.

New Trainer

Bölkow also has designed and produced the prototype Klemm Kl 107, a 3-seater trainer suitable for aerobatics and business flying. It is now going into production.

Presently Bölkow is developing a 4-seater plane for business flying to compete with the Cessna 310, but further technical details are not available. Wind tunnel tests have been completed and it is now in the mock-up stage. Bölkow expects first flight tests early next year.

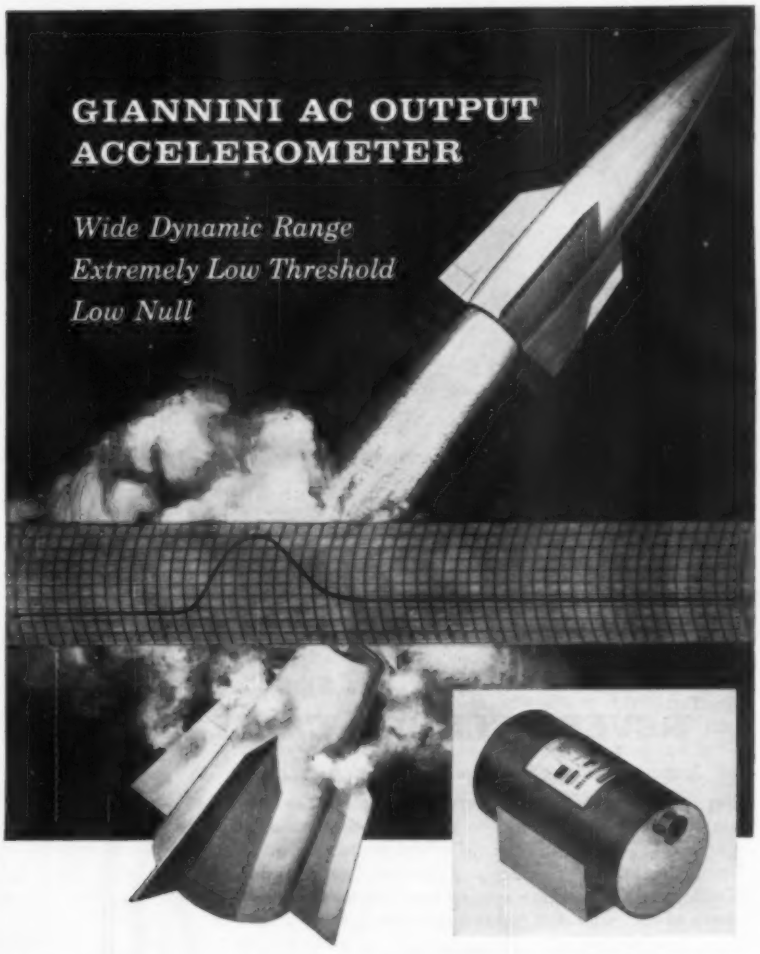
Bölkow-Entwicklungen K.G. is soon to join the Flugzeug-Union-Süd development group, which will be headed jointly by Messerschmitt, Thalau, head of Heinkel's research and development, and by Bölkow. Prof. Dr. Ing. Karl Thalau says that the purpose of this new setup will be to "prepare for the bigger tasks of the future." Bölkow, on the other hand, believes that this is only the first of several similar partnerships to be recommended for the German aircraft industry by the Defense Ministry in Bonn. Following the recent British examples it is, he says, an attempt to pool resources so that the German industry can begin to turn out its own designs quicker than would be possible were the individual firms to continue their efforts alone.

Weser-Built Transports

Major production items of the Weser Flugzeugbau G.m.b.H. are components of the French-designed Nord 2501 Noratlas. In this work it operates as part of the Construction-Group North sharing the production of the twin-boomed transport.

Another solid chunk of Weser's earnings comes from de-cocooning U.S.-built Republic F- and RF-84Fs, and assembling Vertol H-21 helicopters.

But like most other companies in the burgeoning German industry, they have hopes of developing their own projects to production status. Parallel with this future work, they hope to get IRAN



ACCURATE, CONSISTENTLY RELIABLE AC output, proportional to linear acceleration, is provided by this new Giannini accelerometer. Available in ranges from ±1 g to ±20 g, the instrument has a full scale output of 6 volts which may be fed directly into a relatively low impedance with little or no phase shift.

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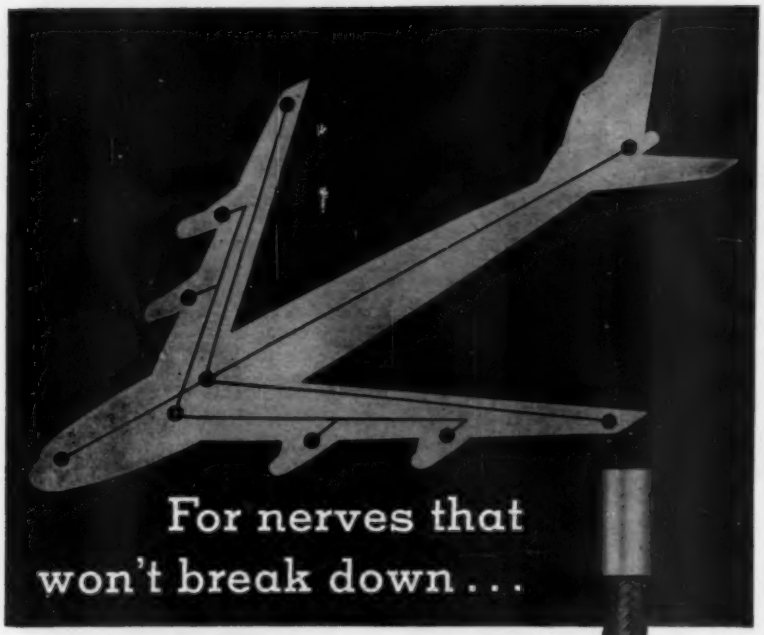

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contracts for inspection and repair of both Republic and Vertol types.

Weser is part of the Krupp industrial empire; a majority of its stock is held by Krupp. This is its primary organization. For the purposes of the Noratlas contract only, it is part of the Northern group along with Hamburger Flugzeugbau and Siebel.

Satellite Plants

The company operates administratively out of Bremen offices on the property of its parent firm, Weser Aktiengesellschaft, a heavy industry specializing in shipbuilding and repair. There are three satellite manufacturing plants which survived the war—largely by being overlooked by target selection teams in their search for big game in the Bremen-Hamburg area—and today employ about 2,000.

At Lemwerder, about 10 miles from Bremen, the major job is a merry-go-round. The company de-cocoons Republic-built F-84Fs and RF-84Fs, rehabilitates them, and then puts them back into long-term storage. This paradoxical performance currently depends on the almost complete lack of pilots for the new Luftwaffe; as the force builds up, these airplanes will be released to operational units. Meantime they sit in long lines outside the factory.

The only difference between the job at Lemwerder and another job at Einswarden, about 30 miles from Bremen, is in the type of aircraft. This second plant in the Weserflug complex assembles Vertol H-21 helicopters, repairs or replaces whatever is necessary, and puts the rotary-wing aircraft into storage.

Major components for the Noratlas are also made here and shipped to Hamburger Flugzeugbau for assembly.

Third plant operated as part of Weserflug is at Varel, also about 30 miles distant. This shop has for years been a precision-parts manufacturer, and its major output remains so today. Its production goes to Weserflug as well as to other industries.

Rotary-Wing Rebirth

Germany's first postwar helicopter, designed by Professor Heinrich Focke, is being developed in collaboration with financial and technical support from the Bremen auto firm of Carl Borgward.

Borgward personally became a helicopter enthusiast after one ride from his factory yard in a Hiller 360, and suggested to Prof. Focke that mutual collaboration would be a good thing. Focke, who has been working on helicopters for about 25 years, now has a design team of 23 engineers and more supporting personnel. Their first project is a three-seat, conventional single-rotor helicopter powered by a 260-hp. Lycoming VO-435A1A piston engine. Second project is believed to be a 40-

seat helicopter for troop or civil transport use.

The three-seater is expected to fly this month after completing its 100-hour ground run. It was designed from the start as a commercial venture, and should sell for the equivalent of $37,500 to $50,000. Design is in complete agreement with U.S. Civil Aeronautics Administration rotary-wing requirements which were adopted by the German Ministry of Transport as its criteria.

Presumably if the helicopter is a technical success, it will be produced and marketed through the Borgward organization.

First fuselage of the Nord 2501 Noratlas, being partially built and completely assembled by HFB, is now out of the jigs and in the final assembly hall. Five more fuselages are almost complete and major components for another three or four are in their fixtures.

Total production run of the Noratlas is 112 airplanes, with components built by HFB, Weserflug and Siebel.

Biggest production item so far for the Hamburg firm has been the design and fabrication of about one thousand lightweight seats for Lufthansa's Lockheed Super-Constellations and Vickers Viscounts on order.

New Transport

In the design revision stage is a twin-engined turboprop transport for short-range work, submitted last year to prospective airline customers and now being revised in the light of their comments. HFB is reluctant to talk further about the airplane until the revision is complete.

With the Noratlas work just getting underway, the company has little to show except wide open spaces on the assembly floor and much component fabrication. The tooling has been largely developed by the French designers and built by the Braunschweigische Maschinenbauanstalt or by HFB; it is well along and largely complete.

Work is progressing on an airfield adjacent to the factory which will be completed before the first flight of the first Noratlas.

The company is the former aircraft division of Blohm und Voss, famous during World War II for construction of flying-boats, including a six-engined giant that now lies at the bottom of a nearby lake, its hull torn by gunfire from strafing fighters. The shops survived the war; they were camouflaged with heaped earth between the buildings and the whole business planted with shrubbery and trees.

The assembly hall is the former experimental shop where prototype flying-boats were built.

Still owned by the Blohm family, HFB employ about 1,200 people.

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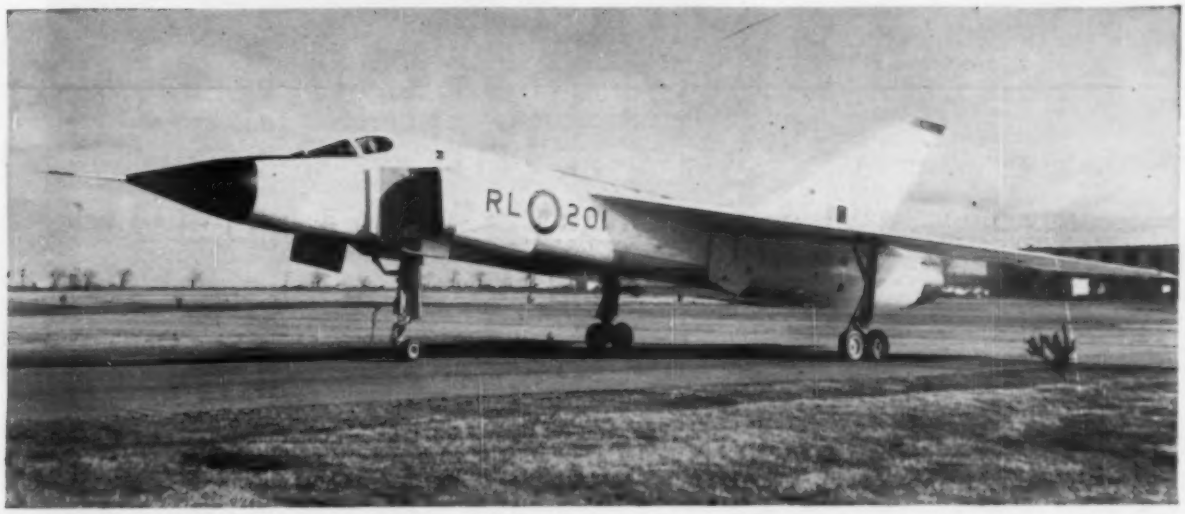

AVRO CF-105 ARROW

New Aircraft Boost Canadian Industry

Toronto—New aircraft have kept Canada's aircraft manufacturers busy this past year and will be an important part of this year's manufacturing operations. All three major Canadian aircraft manufacturers have new aircraft being test-flown or about to be tested this year, both for military and commercial purposes.

At Toronto, Avro Aircraft, Ltd., was scheduled to test fly its supersonic delta-wing twin-jet bomber destroyer CF-105 Arrow Mark I early this year. Also at Toronto, de Havilland Aircraft of Canada, Ltd., is to test fly its first twin-engined DHC-4 Caribou transport in June.

At Montreal, Canadair, Ltd., hopes to complete this year the prototype of its new CL-41 jet trainer, which also has potentialities as an executive type four-place aircraft. Canadair is also working on a new turboprop military and civil transport CL-44, a transport version of its CL-28 Argus, maritime reconnaissance plane being built for the Royal Canadian Air Force, which is based on the British Bristol Britannia.

A new Canadian jet engine, Iroquois PS13, being built by Orenda Engines, Ltd., Toronto, is also due for extensive testing this year both on the ground and in the air. A B-47 bomber has been loaned Canada by the United States Air Force to act as a flying test-bed for the Iroquois. The engine, incidentally, is to be manufactured under license in the United States by Curtiss-Wright Corp. Orenda is completing a new high altitude test tunnel at its Toronto plant, scheduled for use this spring.

Production High

While these new designs are of major interest in the Canadian aircraft manufacturing industry, the various companies are busy with production of many other aircraft and engines. Despite the lay-offs in some industries, the aircraft industry has retained high employment and continues to be one of the top industries in Canada.

Military Exports

In the past year the industry has been quite busy with export orders for military aircraft which are now nearly completed. Western Germany, South Africa and Colombia took deliveries of Canadair-built Sabre aircraft powered with Orenda engines. An $8,000,000 replacement order of these engines is now nearing completion by Orenda Engines.

Belgium has taken delivery of the first CF-100 twin-jet interceptors built by Avro Aircraft and powered with the Orenda 14. Avro Aircraft Services Ltd. has been formed to service the aircraft and engines in Europe.

De Havilland Aircraft of Canada is building single-engined Beaver L-20 and Otter U-1 aircraft for both military and civil users throughout the world. An order for the Indian Air Force was completed recently. It is of interest to note that these two aircraft are currently in use in Antarctica by expeditions of the British, United States, New Zealand, Australian, Japanese and Chilean governments for the International Geophysical Year. De Havilland's twin-engined Caribou has been ordered as a troop transport by both the Canadian and U.S. armies.

All three plants are busy with orders for the Canadian government. Avro Aircraft is continuing production of the CF-100 Mark V, now in use by the RCAF in Europe and Canada. The program of the CF-100 Mark VI was scrapped by the Canadian government after the first plane was flown, partly as an economy move and because of the hopes of getting the CF-105 Arrow Mark I into early production. Five Arrow Mark I aircraft will be completed before production starts on the Arrow Mark II which will be powered with the Orenda Iroquois engine.

The change in military thinking to guided missiles also featured in the government's decision to scrap the CF-100 Mark VI. Defense Minister George Pearkes stated at the roll-out of the CF-105 Arrow last October, that he thought it would likely be the last manned fighter aircraft to be produced for the RCAF.

Tracker

De Havilland Aircraft, in addition to its Beavers, Otters, Caribou and Chipmunk trainer, is busy with the Grumman CS2F-1 Tracker maritime reconnaissance aircraft for the Royal Canadian Navy. Orders on hand for this aircraft will maintain production till well into 1959.

Canadair has on production the Sabre VI for Western Germany and the CL-28 Argus for the RCAF. The Argus is the biggest aircraft ever built in Canada. Company has started production of prototypes of transport and

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AVRO CF-100

freighter versions of the CL-44, both for military and commercial users. The military version is being built for the RCAF.

Canadair is still building T-33 jet trainers for the RCAF for use of aircrews of 12 NATO countries training in Canada.

In addition to Orenda Engines, Ltd., which is turning out various models of its Orenda engine for the RCAF at Toronto, three other engine makers currently have plants in operation at Montreal.

Canadian Pratt & Whitney, Ltd., expanded its plant outside Montreal last year and now has nearly 850,000 square feet of floor space for the manufacture of Wasp and Wright engines and parts, as well as Hamilton Standard propellers. The company does a big export business in piston engines and spare parts. Additional space was also required for overhaul on Sikorsky helicopters for which the company is Canadian sales agent. Canadian Pratt & Whitney also has under development a small jet engine.

Addition

Rolls-Royce of Canada, Ltd., has begun construction of a $1,000,000 plant addition which will expand its space by 25%. No engines are now being manufactured, but overhaul is done on Rolls-Royce Dart engines for Trans-Canada Airlines Viscount turboprop aircraft. Company will also do overhaul on the Dart engines to be used in the Fairchild F.27 Friendship aircraft and the Grumman executive aircraft. Expansion has been started as well for the space needed to overhaul the Conway by-pass jet engines for the six DC-8 transports and the Tyne engines for the 20 Vickers Vanguard aircraft ordered by TCA.

Bristol Aero Engines, Ltd., at Montreal, and its subsidiaries at Winnipeg and Vancouver, do overhaul work on Rolls-Royce Merlin engines powering Canadair-built North Star transports in use by TCA and the RCAF. The plants also do work on a number of other engines for the RCAF, maintain engine test cells and have a fully equipped plating shop for aircraft parts.

Maintenance

There are a number of smaller companies across Canada which do a big part of the overhaul and maintenance work for the many small airlines which serve Canada's northland. Some of these companies also do work for TCA, RCAF and Canadian Airlines.

With completion this past year of the Mid-Canada and Distant Early Warning radar networks in northern Canada, there was a closer integration of North American defense by the Canadian and United States governments. Canadian Air Marshal Roy Slemon was named deputy commander-in-chief of the North American Air Defense Command (NORAD) at Colorado Springs. Until NORAD plans are approved by both U.S. and Canadian governments, Canadian participation in any air activity in the north will be directed by the RCAF air defense command at St. Hubert, near Montreal.

Growing Canadian-American cooperation was also shown in participation by the RCAF air defense command's nine squadrons with USAF in a series of cross-border training exercises this past year. The RCAF squadrons now

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are all equipped with the Avro CF-100 Mark V interceptor.

Government policy is for closer co-operation in North American defense. To this end the RCAF currently has a team of officers and men with CF-100 aircraft at the U.S. naval station at Point Mugu, California, to test the Sparrow II missile as armament for the CF-100 and CF-105 Arrow aircraft.

Canada has done little by way of development of guided missiles and has abandoned its own Velvet Glove rocket development project. De Havilland Aircraft at Toronto and Canadair, Ltd., at Montreal, have both established missile divisions. Canadair has a nominal contract to make the Sparrow in Canada, and de Havilland has done mainly experimental work which is on the classified list.

Close relationship is also maintained at such northern Canadian bases as Fort Churchill on the west coast of Hudson Bay, and at Frobisher Bay on Baffin Island. At Churchill both Canada and the United States do experimental rocket firing, mostly Aerobee rockets, and test aircraft and equipment for cold weather operations.

At Frobisher Bay both air forces have an operational base and the Canadian government is building a big commercial airport for use of trans-polar civil aircraft on routes between the west coast and Europe. There is also close co-operation between the two air forces at a number of other northern Canadian points, including Goose Bay, Labrador, and on various Arctic islands.

Defense Planning

Canada's entire defense plan is based on having fast enough aircraft and electronic detection equipment to intercept some of the missiles and manned aircraft which can be launched against North America from the north or from either seaboard. The CF-100 and CF-105 are designed primarily for this role of intercepting airborne attackers in conjunction with radar fences in the northland.

The RCAF coast reconnaissance aircraft, including the new CL-28 Argus, and the Royal Canadian Navy's CS2F-1 Tracker, along with destroyer surface vessels, are designed to intercept missiles and aircraft from submarines, to detect and destroy the submarines. Canada does not at present plan any other type of fighter or retaliatory aircraft, relaying on the United States strategic air force for retaliatory operations.

The supersonic CF-105 Arrow, if it comes up to expectations, is expected to transport guided missiles to within killing range of attacking missiles and manned aircraft. Its electronic system and that of its missiles would handle this job. It would likely not see its target, but be back for another load of

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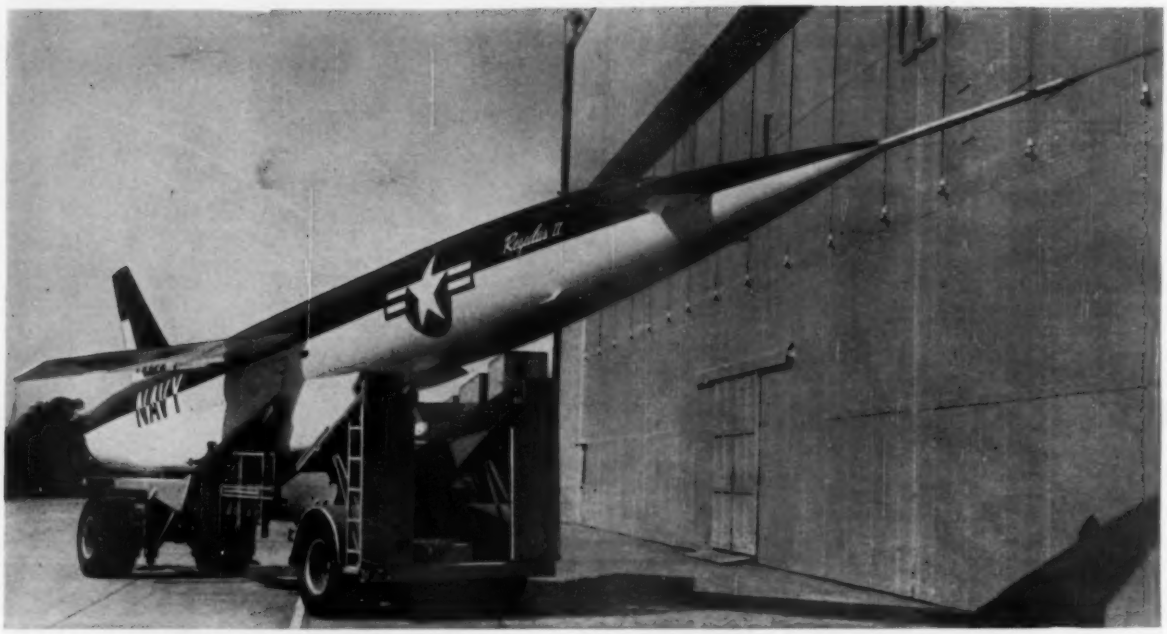

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166	167	168	169	170	171	172	173	174	175	176	177	178	179	180
181	182	183	184	185	186	187	188	189	190	191	192	193	194	195
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YOUR BUSINESS

MANUFACTURING
- Aircraft ☐ Missiles ☐
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missiles by the time its first missiles had found their target. There is even hope that the CF-105 will be ordered by USAF. Certainly USAF officials have watched its development from the beginning.

While information is not available for security reasons, it is known that Canadian defense scientists are working on new electronic means of detecting and tracking missiles which could reach North America from the north or from either ocean. Canada's Defense Research Board is an active organization, working closely with its American counterpart as well as with its affiliated military services.

Overseas

In addition to its North American operations, the RCAF has an air division in West Germany and France with the NATO forces. The past year four squadrons of CF-100 interceptors were added to the eight F-86 Sabre day-fighter squadrons maintained in Europe, giving the RCAF air division around-the-clock combat capability. The RCAF trained in Canada aircrews for the Belgian and West German air forces now using CF-100 and Sabre fighter aircraft, respectively.

The RCAF Air Transport Command operated a wide range of aircraft on a world-wide basis during the past year to Indo-China, the Middle East, Europe and throughout Canada. It operated numerous trips to Saigon where Canadians are serving on the Indo-China Truce Commission, and to the United Nations Emergency Force in the Middle East, where Canadian troops are also in service. Till late last year the RCAF maintained a base near Naples, Italy, for this service to the UNEF.

RCAF forces were busy during the year on search and rescue missions throughout Canada and on both coastal areas, while its Maritime Air Command worked closely with the Royal Canadian Navy and on various NATO exercises on the Atlantic coastal region. RCAF strength at present is 51,000 officers and men on active service with 5,500 in the reserve.

Defense Budget

It is estimated that the RCAF accounts for a large part of the $1,773 million Canadian defense expenditures this year.

The northern radar warning networks have brought a supply and maintenance problem now that they are in operation. Rather than have the RCAF transport command look after this, the work has been let out to civilian operators, who also do a major part of the aerial mapping and photography of Canada's northland under government contract.

Okanagan Helicopters, Ltd., Vancouver, and Spartan Air Services, Ot-

HONEST JOHN artillery rocket depends on G-E electric heating blanket (inset) to bring missile to uniform operating temperature before launching.

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Successful launch—and flight—of the Honest John depends upon exact propellant temperature at the moment of firing. A General Electric heating and insulating blanket—which shrouds missile from nose to nozzle—provides and maintains that temperature!

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Why *your* truth dollars?

Because Radio Free Europe is a private, non-profit organization supported by the voluntary contributions of American business and the American people. And *your* dollars are urgently needed to keep it on the air . . . to help operate its transmitters, pay for its equipment and supplies, and its scores of announcers and news analysts in 5 languages.

Help keep the Reds in the red. Send your truth dollars to Crusade for Freedom, care of your local postmaster.

FREEDOM IS NOT FREE!

Your Dollars Are Needed To Keep Radio Free Europe On The Air

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tawa, split major job of re-supplying the Mid-Canada radar network for the RCAF.

Okanagan claims to have the world's largest commercial helicopter fleet, operating 44 helicopters in its various companies throughout Canada. It has 26 Bells, 17 Sikorsky S-55s and one Sikorsky S-58.

Spartan has 24 helicopters in operation and has been loaned nine Vertol H-21Bs by the RCAF for part of its Mid-Canada line supply job. Spartan operates a big helicopter overhaul plant at Ottawa, opened early in 1957.

Kenting Helicopters, Ltd., Toronto, has three Sikorsky S-55s used for supplying bases on the Distant Early Warning radar network. It has been operating helicopters since 1947.

These three companies, as well as a number of smaller operators, do aerial mapping, photography and mining work for the Canadian federal and provincial governments and for mining companies. They use a wide variety of single and twin-engined fixed aircraft and use helicopters for survey work.

Aerial Surveys

Much of the mining and oil development in Canada in the past 35 years has been the result of aerial surveying done before prospectors and geologists went in from the ground to stake claims. Practically all finds in recent years have been made as a result of studies done in comfortable offices from photographs and maps supplied by aerial surveyors.

Special electromagnetic equipment has been developed to record mineral and oil deposits from the air. Data compiled electronically from this airborne equipment has been used to decide where to send prospectors and geologists and diamond drilling teams in the far north, even to the Arctic Circle region.

In addition to doing photographic survey work for the Canadian government in the Arctic regions this year, these firms and a number of others have currently under contract photographic survey jobs in the Caribbean and South America. Affiliated companies also have done survey work in the past year for the British government in Antarctic.

While bulk of Canadian aviation manufacturing is for military production, Canada's aircraft industry is gradually turning to civilian production for Canadian airlines as well as export sales. Civilian transports have for a number of years been sold throughout the world by de Havilland Aircraft of Canada.

Canadair is now turning to making transports for commercial users throughout the world and Avro Aircraft has an unnamed project underway which its officials will only say has commercial applications.

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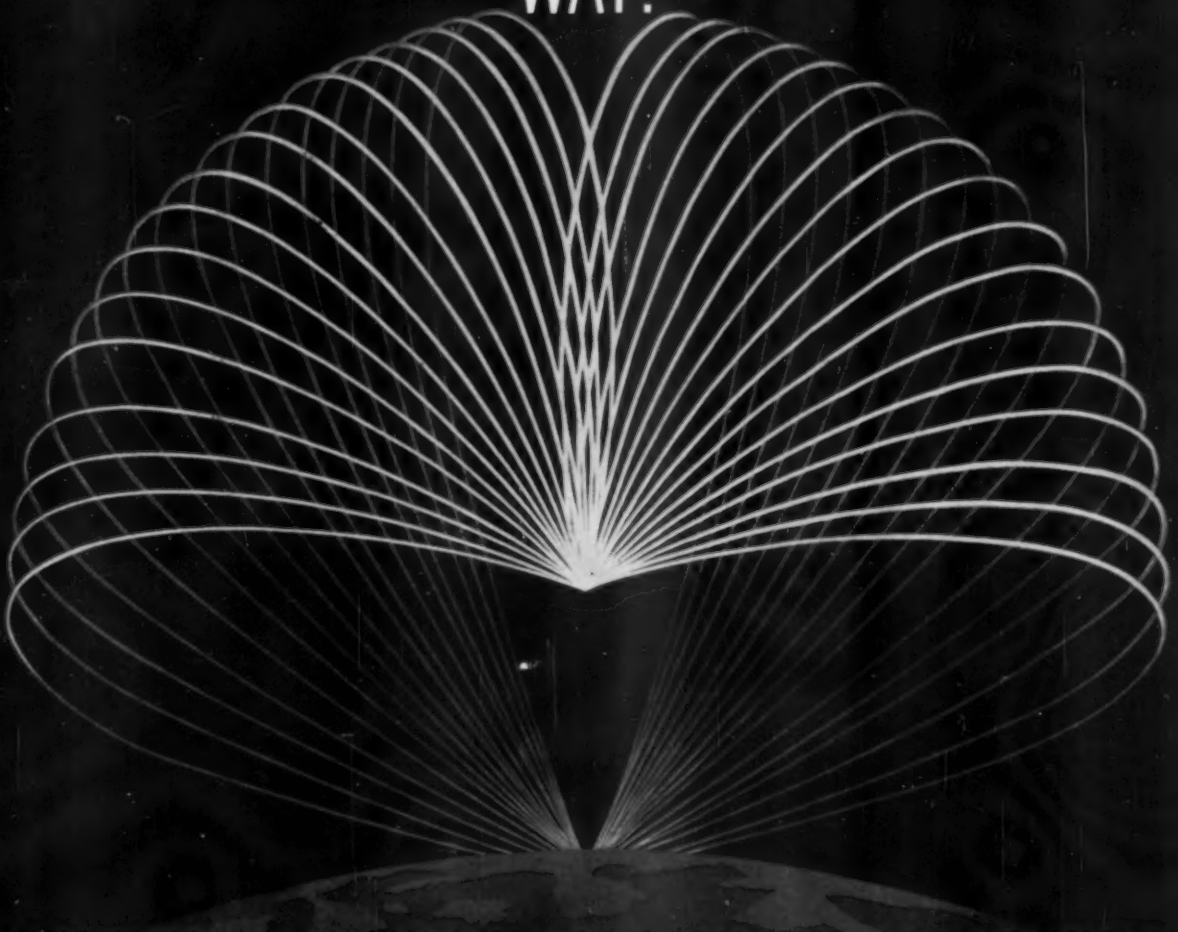
WHICH WAY?



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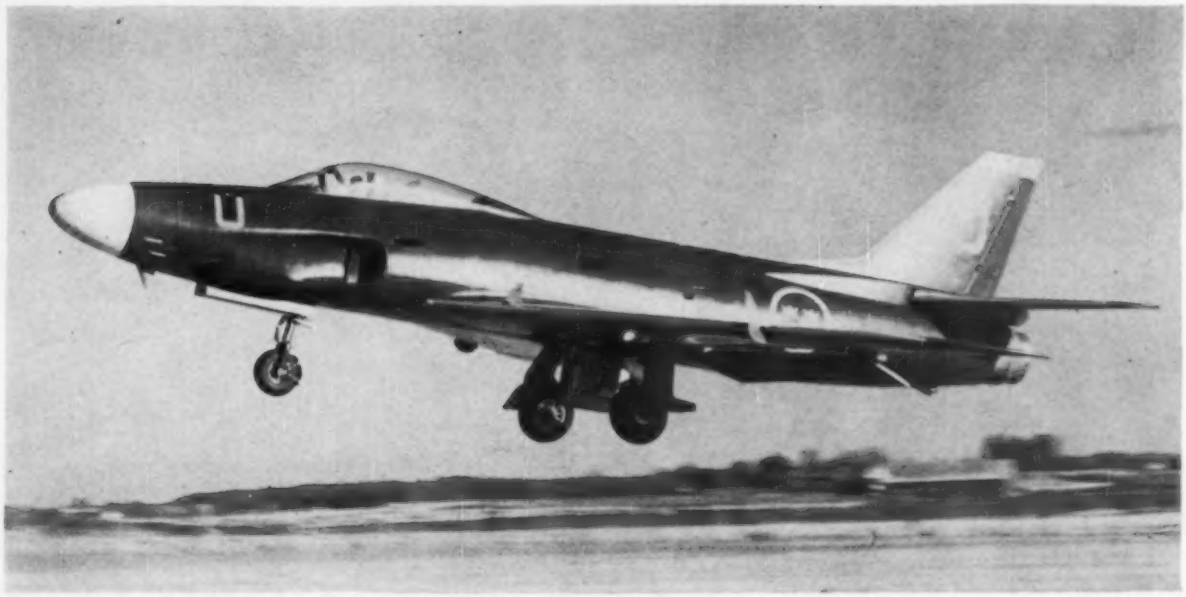


SAAB J-32B ALL-WEATHER FIGHTER

Swedish Airpower Modern and Versatile

Stockholm—Unique industry-air force team forges and flies the planes that make up Sweden's inventory of air power.

The Royal Swedish Air Force (RSAF), commanded by Lt. Gen. Axel Ljungdahl, has been an independent military service since 1924. Its current strength is about 1,200 combat aircraft, mostly sweptwing jets.

The Svenska Aeroplan Aktiebolaget (Saab), a privately owned corporation, formed in 1937 and merged with the Bofors organization in 1939, is this country's only producer of military aircraft.

Cooperation at all working and administrative levels between the Swedish air force and Saab has given this little country a large, high-quality force equipped with modern and versatile aircraft that can strike targets anywhere along the defense perimeter from bases anywhere in Sweden.

Sweden's strategic position makes its defense a tough problem for air planners to solve. This country, a little larger than California in size and about equal to New York City in population, must defend a frontier that stretches from above the Arctic circle 1,200 mi. south to the 56th parallel. That distance is roughly the airline distance between New York and Miami.

Obvious Threats

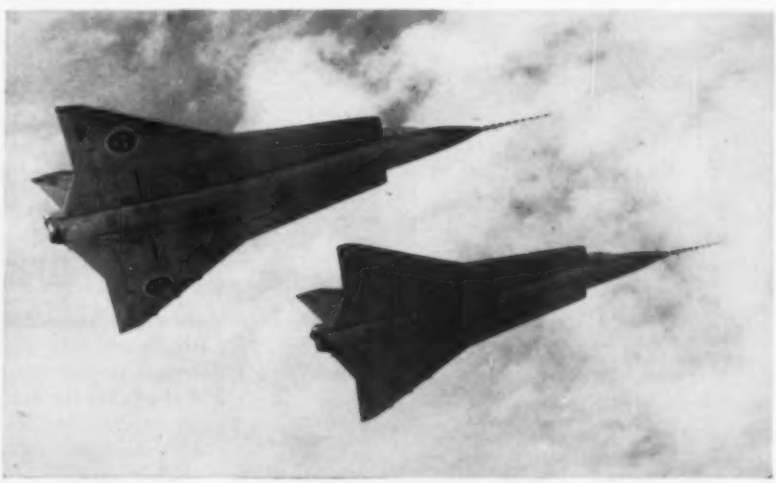
The threats are obvious. There might be a land strike across the northern border or an amphibious assault across the cold waters of the Baltic Sea, accompanied by air attacks. Or an enemy might strike only by air at the populous and industrial southern portion and at northern military bases.

These threats pose obvious problems, to which there is only one clean-cut solution: Swedish airpower must be an all-weather striking force, capable of mounting either defensive or offensive operations against air or surface targets anywhere along the defense perimeter of the country.

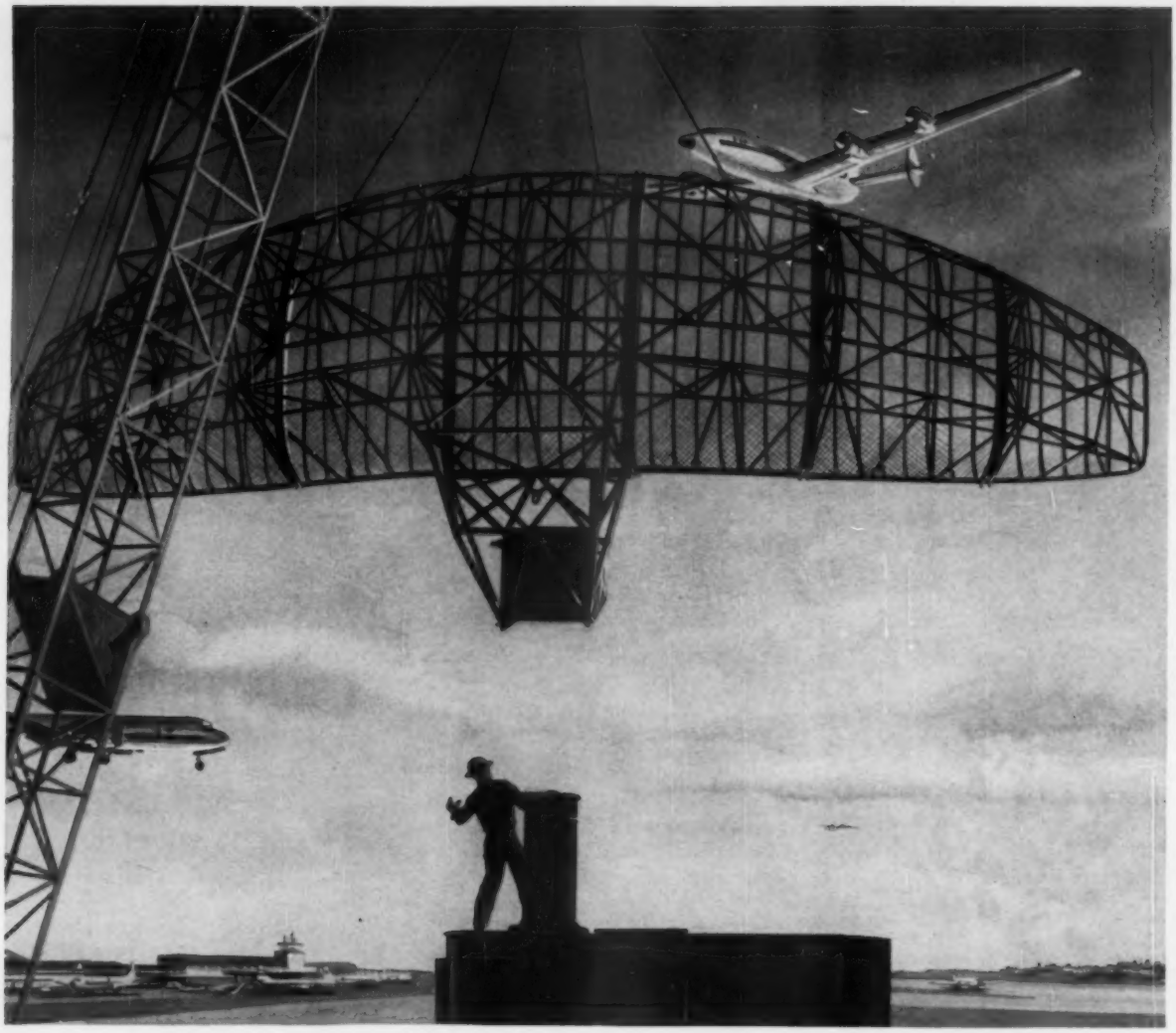
For this tough task, Sweden could today count on about 1,200 combat airplanes, mostly all sweptwing jets with transonic performance. The majority of these would be the Saab J-29 Flying Barrel fighters, now in the declining years of their allotted seven-year lifespan. Also composing a major portion of the air defense squadrons are 100 Hawker Hunters, purchased from Britain as a stop-gap measure a few years ago.

Air Strength

The air strength is divided into four air divisions: two fighter divisions, one attack division and a combined recon-



SAAB J-35 DRAGON INTERCEPTORS



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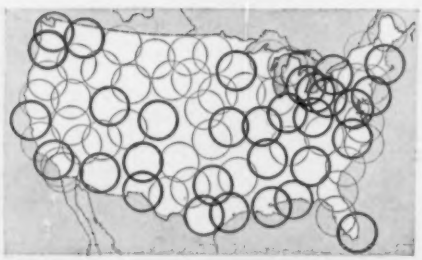

Raytheon radars at 27 of the 31 heavily circled areas will soon be operating as part of C.A.A.'s flight control network. Light circles indicate future coverage.

"More sky to fly in"—the goal of the Civil Aeronautics Administration—is near realization. The first of the new Raytheon Flight-Tracker radars ordered by C.A.A. is now being installed at Indianapolis. Installations at six other major cities will follow shortly, and the nation-wide system linking 27 airports is scheduled for completion this fall.

Flight-Tracker radars help safeguard aircraft in every stage of flight. They detect and track planes in any weather—even in storms—pinpoint position of four-engine transports up to 200 miles distant, at altitudes up to 70,000 feet.

This new equipment, designed and built by Raytheon, will speed schedules, reduce airlane congestion. By readying the skyways for the Jet Age, Raytheon helps solve a major U.S. transportation problem—air traffic control.

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naisance and "far-north" fighter unit.

Only one air force wing has all-weather capability now, and as any wintertime visitor to Sweden will confirm, this is not enough. Bad weather is so predictable during the winter that Saab schedules overhauls then on its prototype flight test airplanes, knowing full well that the chances of flying them during that period are very small. All-weather capability will be rapidly increased through the next few months as squadrons are built up with an A/W version of the Saab Lansen.

Ground environment radar, similar to the U. S. Sage setup, is under development for Swedish defense now, but won't be available until the 1960s as an operational system. By then, the Swedish air force should have substantial quantities of the Saab J-35 Draken with all-weather capability, air-to-air missiles and combat speeds in the Mach 2 class.

Sweden's planning for the atomic age has shown foresight. Saab's underground factory, completed before the end of World War II, and the air force's ready-alert underground hangars are two examples of atomic-age planning translated into quick action.

Sweden's strategists also realized that pure dispersion was not the answer for attack by nuclear weapons. There is no such thing as a dispersed force centered around an airfield, they argued, if the enemy is using nuclear weapons. Their solution has been to build separate air bases, operated on a standby-alert basis, so that if a nuclear strike came, the force could be in the air and doing damage to the enemy while he was hitting their bases.

Air Board Task

Combined jobs of research, development and procurement for the Swedish air force are done by the Air Board, an organization corresponding to a miniature merged USAF Air Material Command and Air Research and Development Command. The board combines both staff and executive functions, supervises and does some of the basic research and primary development—it was an Air Board scientist who developed the extremely effective afterburners used on both the Saab J-29 and Draken—and spends the money for procurement.

This last function drew the fire of some Swedish parliamentarians who criticized the board's 1957 deficit of $35 million, a substantial portion of the usual annual budget of about $1,600 million. Comments about mismanagement were passed in open sessions of the government; the furore forced Lt. Gen. Ljungdahl to make public comment against the government's accusations. Ljungdahl's strong-

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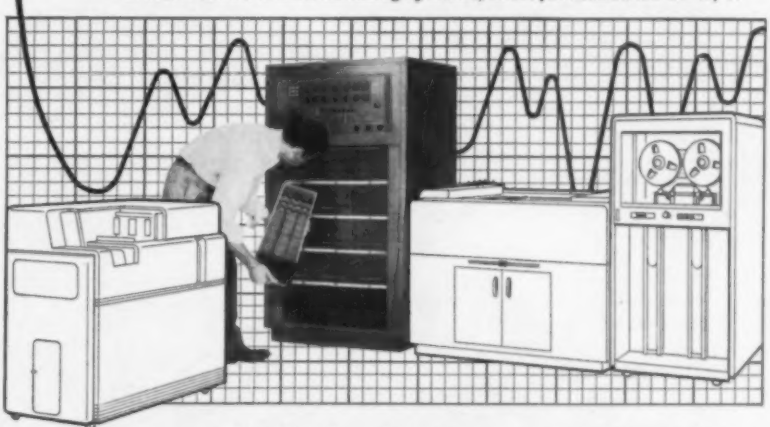
The Beckman Tape-to-Curve Converter is an invaluable supplement to users of IBM 700 series and IBM 650's equipped with magnetic tape. It is essential in any application where the rapid plotting of large quantities of data is important – from the evaluation of geophysical data to the graphical depiction of chemical processes, aircraft tests, or business statistics.

For more information on the Beckman Tape-to-Curve Converter or other modern data handling systems, write for Data File 319-14-7.



This typical data plotting installation consists of the Beckman Tape-to-Curve Converter, IBM Reproducing Punch, IBM Magnetic Tape Unit, and an Electronic Associates Variplotter.

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est point is the long lead time between placing an order and having to pay for it. During recent years real wages have increased by 12-18%, sanctioned of course by the government, and this represented the major portion of the deficit.

Air Budget

Sweden's defense budget has been considerably increased from the preliminary estimates to a current proposed value of about $520 million. Normal proportion allotted to the air force is about 40%; if that figure remains unchanged, the RSAF can expect to have about $208 million this year.

Defense costs will be permitted to increase by about 2.5% per year to compensate for increased costs of technical development, and there will also be compensation for the "automatic" price increases. Considerable money is expected to go to nuclear research weapons research.

This budget for Fiscal 1958-1959 is based on an agreement between the four political parties and is the basis of their definite proposal to Parliament. Exact distribution of the final approved budget is subject to the recommendation of military experts.

There is no question but that Sweden gets good value for its airpower money. On a total annual budget that will this year approximate about $200 million, the RSAF maintains and operates a 1,200-plane air force and buys new equipment as well.

With the exception of a few units in the air force, all of this new equipment comes from one organization: Svenska Aeroplan Aktiebolaget (Saab). This privately-owned enterprise works in closest cooperation with the air force and the air board.

The company has its main production plant and corporate headquarters at Linköping, about 100 mi. south of Stockholm, plus some other satellite plants and offices. Total employment is about 7,000. Last year's profit was about $1.4 million.

Current Production

Saab's underground parts factory and above-ground component and assembly shops are currently concentrating on building up production of the J-35 Draken while maintaining the peak production level of J-32 Lansens. Some modernization work is being done in bringing the J-29 "Flying Barrels" up-to-date to give them an operational life approaching a decade. They entered service in 1951 as the first sweptwing fighters in Europe and stayed in production until two years ago when the Lansen began to supersede them on the lines.

Biggest production space allotted

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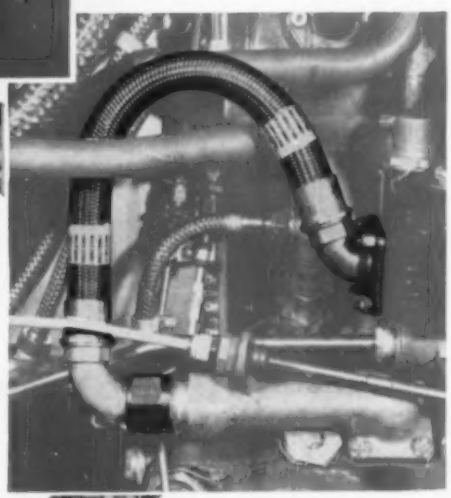

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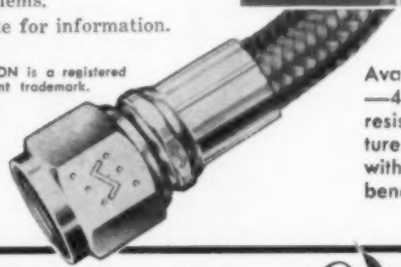

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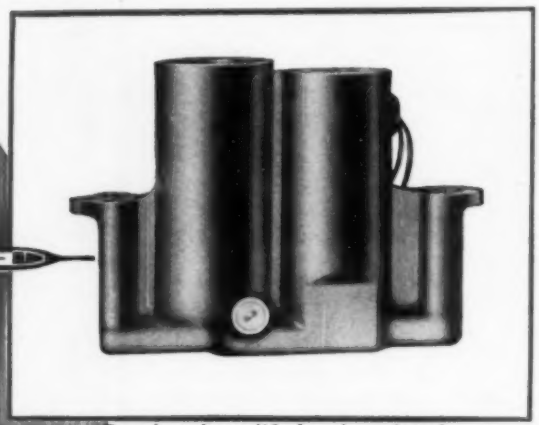

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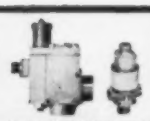

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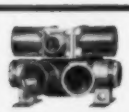

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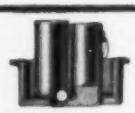

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to the Lansen, in these three versions:

• **Lansen A-32A all-weather attack-version** which began service with the RSAF in late 1955. It will arm all attack units. The plane is powered by a Swedish-built Rolls-Royce Avon RA.7R with afterburner. Armament is four 20-mm. cannon in the fuselage nose, plus external stores including unguided rockets, bombs, napalm tanks and Type 304 guided missiles.

• **Lansen J-32B all-weather fighter,** intended to give the RSAF increased capability in this field where only one wing of aging de Havilland Venoms is now operational. Plane is basically a standard Lansen with a higher-thrust Swedish-built Avon plus the usual fire-control equipment, and navigational avionic equipment and heavier armament.

• **Lansen S-32C photo-reconnaissance model** for both conventional and radar reconnaissance. Plane is scheduled to go into service soon, replacing the last of the piston-engined aircraft in combat wings. Only obvious external difference is in the changed nose shape to accommodate cameras. Basic dimensions, powerplant and layout of the Lansen remain unchanged.

Next aircraft to hit the production lines will be the double-delta J-35 Draken, a fighter-interceptor with a lot of development life built in. Three prototypes have been flying for more than two years under the rugged operational conditions of Sweden's northland areas.

Night Fighter

First production airplane now has joined the three prototypes and first deliveries to the RSAF are expected in about one year. First of these airplanes delivered will have night-fighter capability, and later models will be completely all-weather. Developments of the airplane now in design stages will raise the plane's speed performance to the Mach 2 level and introduce air-to-air rockets and missiles as armament.

Draken prototype flew in late October, 1955, and production build-up started in 1956. First intended as a replacement for the J-29, the Draken has been named as the RSAF's standard equipment for light attack roles as well as the fighter-intercept job.

Performance range of the plane is outstanding, from a high speed of over 1,000 mph. to a normal stall speed of about 130 mph. During controlled flight tests it has been flown under control at altitude down to about 120 mph. Short field performance is also outstanding. Normal landings with service pilots should require about 2,000 ft. of runway, using both the normal wheel brakes and the brake parachute. Saab pilots, more familiar with the plane, have made minimum-distance landings of less than 1,500 ft. without overheating the brakes. These landings have been made with steep approaches typical of service conditions.

Operational takeoff runs should be about 2,000 ft., and as pilots gain familiarity with the airplane, should decrease to less than 1,500 ft.

Swedish Missiles

Development work on Swedish guided missiles has been primarily a government responsibility until a recent policy change which now brings industry into the business. Two missiles have reached service test stage:

• **Type 304 "attack" missile,** presumably an air-to-surface guided bomb. This weapon has been developed as armament for the Saab Lansen A-32A. Powerplant is a rocket motor, and guidance is all-weather. The 304 is a canard-configuration, with low-aspect-ratio wings mounting vertical surfaces at their tips to give some endplate effect. Forward on the ogival nose are mounted vertical, horizontal controls.

• **Type 315 surface-to-surface ship-launched missile.** This weapon uses a built-in rocket booster and what appears to be a pulsejet engine as a sustainer powerplant. Guidance is all-weather.

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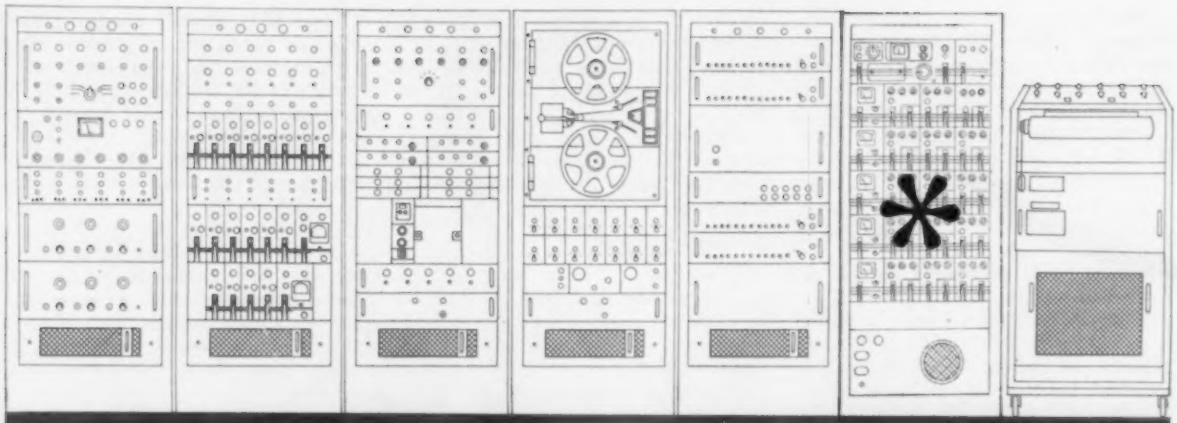

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FIAT G.91 ARMAMENT

Italian Air Growth Sparked by Jets

Rome—Italy's Air Force, for a quarter of a century an independent military service, has beaten many of its postwar difficulties and made the difficult transition to an all-jet operational arm.

Military observers here are most enthusiastic about the Italian Air Force in every aspect. They cite its very high availability rate—around 75% of any squadron's strength is operational at all times—or the overall low accident rate or the gunnery championship they took from the Turkish and Greek Air Forces, no slouches in gunnery.

But the highest praise comes from USAF officers working in the field with the Italian units. Said one Korean combat veteran, "I'd fly wing on any of these boys anytime." In most airmen's books that is the ultimate compliment.

Wartime Record

It hasn't been an easy job for the Italians to work up to their current status. Their showing as an air force in World War II was spotty. But before they were plunged into the war most of them didn't want, they had a strong air force, with advanced designs based on highly developed aerodynamic and structural features ahead of most of their contemporaries.

They began postwar life with handouts of surplus, tired USAF equipment. They bought de Havilland Vampires as their first approach to operational status with jets, later graduated to the more complex and heavier machines like the Republic F-84G. Now their equipment is largely sweptwing, with Fiat-built North American F-86Ks, Canad-air-built North American Sabre 4s, and Republic F-84Fs and RF-84Fs forming the major combat strength.

Italian Air Force has three missions: air defense, ground support and naval support. Its air defense job is geared to the needs of Italy, both as a country and as a part of the long NATO chain stretching around the Iron Curtain. Italy is a 600-mi. link in that chain, parallel to the frontiers of Czechoslovakia, Hungary and Roumania, and strategically is in an excellent position to base interceptors against any major strike over that frontier.

Recent reorganization of the Italian Air Force divided the defense problem into three sectors, placed each sector under control of an area commander. His authority extends over the operational units in his area.

With 20 applications for each available spot in the Italian Air Academy, there is no shortage of prospective officer candidates. Neither is recruiting any problem, with respect to quantity or quality. The legendary driving ability of the Italian shows up in his superb performance as an individual pilot. His innate mechanical ability pays off in the maintenance echelons, where fewer numbers accomplish the same jobs as their counterparts in the USAF, and can show a higher plane availability besides.

It's in money for new aircraft that the Italian Air Force really hurts. Said one high staff officer, "Our money for new equipment is so low it's just not possible to buy anything. We can support some complementary material and buy a few prototypes to keep the industry's technical people alive. Beyond that, we equip with U. S. handouts."

Wartime Losses

Italy's aircraft industry was beaten almost to death by the war. Its best experimental equipment was appropriated by the German allies; the supersonic wind tunnel at Guidonia, which was the world's first data-producing supersonic tunnel, was dismantled by the Germans and started on the journey north. It never completed the trip and rusted to partial ruin in open freight cars on a siding. Plants were

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bombed, and completely destroyed. The country came out of the war beaten, grindingly poor, and with its national morale at its lowest ebb.

Now there is some life again in industry, although nothing like its wartime or prewar standing. The aircraft industry is represented by a handful of the old names—Fiat, Macchi, Piaggio—and a handful of small-scale manufacturers.

Industrial Capacity

Biggest potential for Italian aircraft production lies in the extensive plant area of Fiat's aviation division, centered around the company's headquarters in Turin. Backing up the huge production area, now turning out North American F-86Ks under license and an initial quantity of Fiat's G.91 for tactical trials, are the company's large-scale research and development facilities.

Fiat, well along with the first batch of 30 G.91s, is currently negotiating with the Italian government for production of 20 G.91T two-place trainers which are basically similar to the G.91 and share a large number of interchangeable parts with the fighter.

The G.91A, with a slatted leading-edge wing and integral wing tanks, is in development now. Extra fuel gained is about 90 gal. Weight increase is about 880 lb. of which about 660 is fuel and the rest is structure.

Slats mean the G.91 will be able to pull more Gs, turn tighter at the same speed; takeoff distance also will be cut by about one-quarter, the company figures. It quotes takeoff distance from a grass runway as about 1,600 ft. without external loads and about 2,000 ft. with the loads, against comparable current figures of 2,000 and 2,500 ft.

Range increase estimated is 10%.

Work continues on a photo-reconnaisance version of the G.91, designated the G.91R. Comments by NATO officers during the recent Bretigny trials have encouraged the company to continue this work.

New Helicopter

Most recently, a design team has started work on a cold-jet tip drive helicopter with financial support for the project coming from both the Italian government and the Mutual Weapons Development Program. Tests of some helicopter components began last March and are still under way. Company sources say the scheduled flight date is this year, but some observers think this is somewhat optimistic.

A series of small gas turbines in thrust categories up to 6,000 lb. is being developed actively by Fiat. The company's first jet engine was the recent 4002 design, which developed about 550 lb. of thrust. Later engines have increased the thrust range available,

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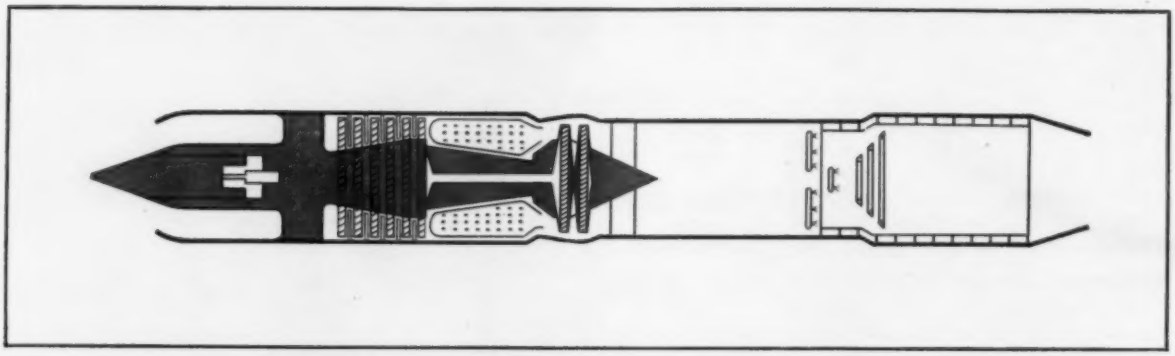

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2	**INCOLOY "901"*** nickel-iron-chromium alloy—matches the mechanical properties of Inconel "X"* age-hardenable nickel-chromium alloy at temperatures up to 1350°F.	**Application:** Turbine disks and similar components where high tensile, creep and rupture strength are needed in the 1000°-1400°F range.
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and one of these is a powerplant in the Bristol Orpheus class which has been designed and tested in component form as a prospective powerplant for the G.91.

Vespas and Flying Boats

Piaggio & Co., once one of Italy's biggest aircraft constructors, is making a slow comeback to its former high position. Best known among non-aviation enthusiasts because of its Vespa motor-scooter, the family car of Europe, Piaggio has two aircraft in current production and two more in development stages.

Largest recent order placed with the Genoa company has been West Germany's order for 75 P-149 piston-engined trainers. Major production of the airplane will actually be done in Germany by Focke-Wulf, now starting delivery on the first few of its contract total of 196. Piaggio had delivered 62 airplanes by mid-January, expects to complete the contract soon. There is a possibility that the airplane production line will be continued at a lower rate.

Piaggio's P-136L amphibian, known in the United States as the Trecker Gull, was planned around a yearly prospective sales figure between 25 and 40 units. Present pace is a little slower than this, but the company feels it may pick up. A landplane development of this amphibian, the P-166, is now in a rigorous flight test program to obtain Italian registration and CAA approval at the same time.

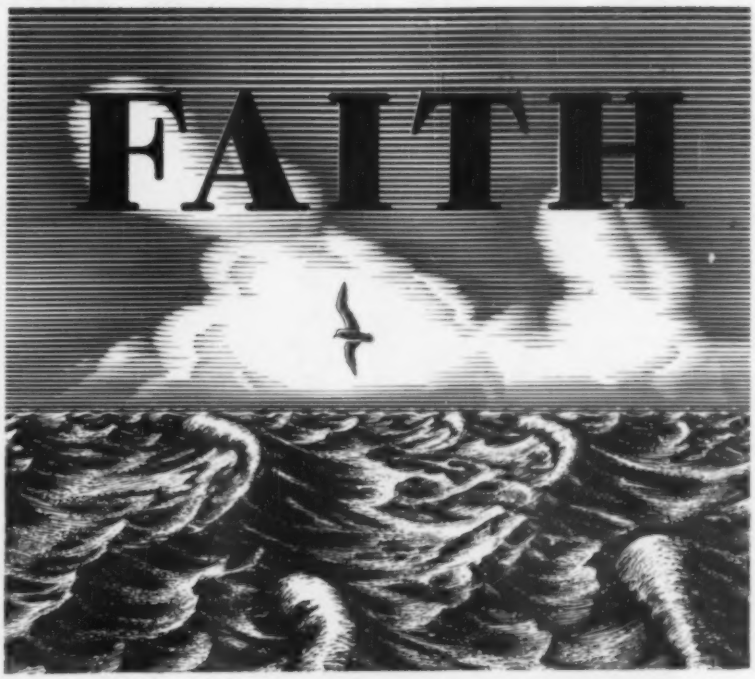
Experimental work centers around an air-sea rescue flying boat, the P-155, ordered in prototype form by the Italian government. First publicly shown in three versions in model form at the Paris Air Show, the flying boat features a high length-beam ratio hull and a designed-in flexibility of the powerplant units. Alternate versions of the plane have been proposed as anti-submarine craft and as civil transports, using either turboprop or piston engines.

Prospective sales for the civil flying boat might be 20 units, for the anti-sub version might be 10.

Production Helicopters

Only current producer of rotary-wing craft in Italy is Costruzione Aeronautiche Giovanni Agusta near Milan's airport. On the company's lines are the Bell-licensed Model 47G, G-2 and H helicopters, and development work is well along on two advanced projects. One of these is in collaboration with Bell Helicopter Corp., and the other is a completely Agusta job.

Like other Italian companies whose aeronautical activities were curtailed after the war, Agusta started the comeback trail with non-flying products.



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● ITALY

First postwar development was a hot racing motorcycle which promptly picked up five world records and made the company name known. Now it makes a light pickup truck and motorcycles in addition to the helicopter production.

More than 300 Bell-designed helicopters have been sold by the company, which holds an exclusive sales franchise for Italy but must compete with Bell and its agents in the rest of Europe. The 47J Ranger is just beginning to move, and Agusta has sold about a half-dozen.

A four-engined feederliner replacement for the DC-3 is taking shape on the floor of Agusta's experimental shop and should now be flying. Designed by Agusta's chief engineer Filippo Zappata, wartime bomber designer for Breda, the plane is powered by four Alvis Leonides piston engines, seats 26 people in two rows of single seats. Two have been ordered as VIP transports by the Italian Defense Ministry, and the company hopes to sell some for internal services.

New Jet Trainer

One of Italy's latest designs is the MB 326 jet trainer, designed by Bazzocchi and built in the Varese shops of Aeronautica Macchi. The plane first flew last December.

Powerplant is an Armstrong Siddeley Viper turbojet in the fuselage, fed from elliptical wing root intakes. Both pilot and instructor have lightweight Martin-Baker ejection seats. Armament installations include guns, rockets and bombs for weapons training.

Macchi is another of the historical names in Italian aviation, having been the constructor of the famous Macchi-Castoldi racing seaplane which took the Schneider trophy for the Italians with a speed of 440 mph. in 1934. Producer of fighters during the second world war, Macchi in the postwar era became a subcontractor and component manufacturer and as such made a major contribution to the Fiat F-86K production program. Quality of their work was very high and loudly praised by Fiat.

Italy's aircraft industry includes many small-scale factories, building low-quantity batches of sport or touring airplanes such as the Aviamilano F.8 Falco and their newest F.14 Nibbio, both designed by engineer Stelo Frati. The market for such aircraft is necessarily limited in Italy because of high initial and operating costs; but such companies manage to sell a dozen or so airplanes.

Their brightest hope is that business flying will come to Europe one day, instead of continuing to be regarded as an expensive way to keep appointments.

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FUJI T1F2 TRAINER

Japan Continues Air Expansion

Tokyo—Japan made important strides last year toward development of a strong air force and aircraft industry. Highlights of this progress:

- **The Japan Air Self-Defense** Force expanded during the year from 519 to 788 aircraft, with much of the increase consisting of domestically made F-86Fs and T-33As.
- **Fuji Heavy Industries** turned out Japan's first home designed jet—the T1F2 intermediate trainer.
- **Earnings from aircraft** sales and overhaul orders skyrocketed from about $10 million to $23 million.

Airpower development has nevertheless been hampered by budgetary shortages, political barriers to runway extension, lack of sufficient skilled maintenance personnel, a sluggish parts supply system, and a weak ground support system. These shortcomings are reflected in the fact that 20 accidents occurred during the year. However, they are gradually being improved as the four-year-old JASDF grows to maturity.

Two new F-86 wings were established in 1957—the 2nd Wing at Chitose, Hokkaido; the 3rd Wing at Matsushima, northern Honshu. The 40 planes of the former will be increased to 60, the 10 of the latter to more than 50 in 1958. A 4th Wing will be activated next summer, probably at Matsushima. The 1st Wing, consisting of 70 aircraft, was set up at Hamamatsu central Honshu, in 1956.

Military Boost

By the end of 1958, the JASDF is expected to embrace 944 planes, including 630 jets. F-86Fs are scheduled to increase from 240 (71 domestically made) to 360; T-33As from 190 (124 domestically made) to 200; F-86Ds from 4 to 60; C-46s from 35 to 38; H-19's from 2 to 4.

In addition, 5 experimental T1F2 intermediate jet trainers will be used. There will be no boost in T-34s (138), T-6s (176), T-28s (1), or Kawasaki KAL liaison planes.

JASDF personnel will probably jump from 22,000 (including 100 jet pilots) to 30,000 (200 jet pilots). About 500 pilots are now being trained, including more than two dozen in the U. S.

Construction

An estimated $5 billion was spent on air base construction in 1957. Two new bases were completed—Yanome, northern Honshu (runway: 5,000 ft.) and Utsunomiya, near Tokyo (6,000 ft.). In addition, the runway at Hamamatsu was extended from 4,600 to 8,000 ft.

A new base (8,000 ft.) at Nyutabaru, south Kyushu, will be ready for use this spring and a new runway at Matsushima (8,000 ft.) will be completed in June. Work may start in 1958 on two additional bases—at Hyakurigahara, near Tokyo, and an undetermined site in central Honshu (8,000 ft.) if land is made available.

The USAF released two bases to the Japanese in 1957—Tsuiki, north Kyushu, and Matsushima. The JASDF hopes that bases at Miho in northwest Honshu and Chitose, will be transferred this year.

Expansion of the JASDF has in no small way been made possible by the rapid growth of Japan's aircraft industry. The $23 million sales it registered last year includes $12.7 million for airframes and engines, $3 million for instruments and accessories, $7 million for overhauling.

Investment in new facilities amounted to about $11.2 million. This is far less than the $16 million spent in 1956, mostly for F-86 and T-33 production facilities, but is likely to rise

sharply this year in preparation for the production of other U.S. aircraft.

Kawasaki Aircraft last year assembled 90 T-33As, in addition to 33 in 1956, and will turn out another 87 by March 1959 when the 210-plane program is due to end. Eighty per cent of the parts are now produced in Japan.

Kawasaki will assemble the P2V7, starting in October 1959. It will turn out one plane per month over a period of 42 months, ending in April 1963. Cost of the program will run to about $70 million, to be met by Japan and the U.S. on a 50-50 basis.

Kawasaki is also hoping for a go-ahead on an F-104 program, which would be carried out simultaneously with the P2V7 project. The government will shortly select this plane, the F-100, the F11F, or the N-156 for production in Japan.

The company hopes to boost output of Bell 47G2 helicopters from 21 to 30 by the end of 1958. Total aircraft sales in 1957: $10.2 million.

Mitsubishi assembled 69 F-86s in 1957. It turned out four in 1956 and will complete the remainder of the 300-plane project by March 1960.

Mitsubishi spent $2.5 million in 1957 on new F-86 production facilities, including a hangar and testing facilities at its Komaki plant.

Helicopters

Mitsubishi is now awaiting government approval of a project for the production of 30 Sikorsky S-55 helicopters. The program, which would cover a five-year period starting in March 1959, calls for payment of an initial $150,000 and 5% royalties to Sikorsky. Mitsubishi would probably turn out the larger S-58 in the future. Total aircraft sales in 1957: $6.6 million.

Fuji Heavy Industries produced two T1F2 intermediate jet trainers in 1957 —one load test airframe, one prototype —using a Bristol Orpheus engine. Another prototype will be completed in February, two other T1F2s later this year.

Fuji manufactured 22 T-34s, three L19s (production started in 1957), and 14 LM-1s in 1957. Total aircraft sales: $3 million.

Ishikawajima Heavy Industries started production of J47 engine parts for the F-86 last year. The first experimental output will be delivered to the JASDF in March.

The Nippon Jet Engine Co. turned out two domestically designed J3 jet engines for the JASDF in 1957 and will produce another two this year.

In the missile field, Japan will sign a contract for the purchase of 14 Sidewinders worth $127,000 from the U.S. in 1958 if the Diet approves the deal, as it is expected to do. Delivery would probably be made in 1959.

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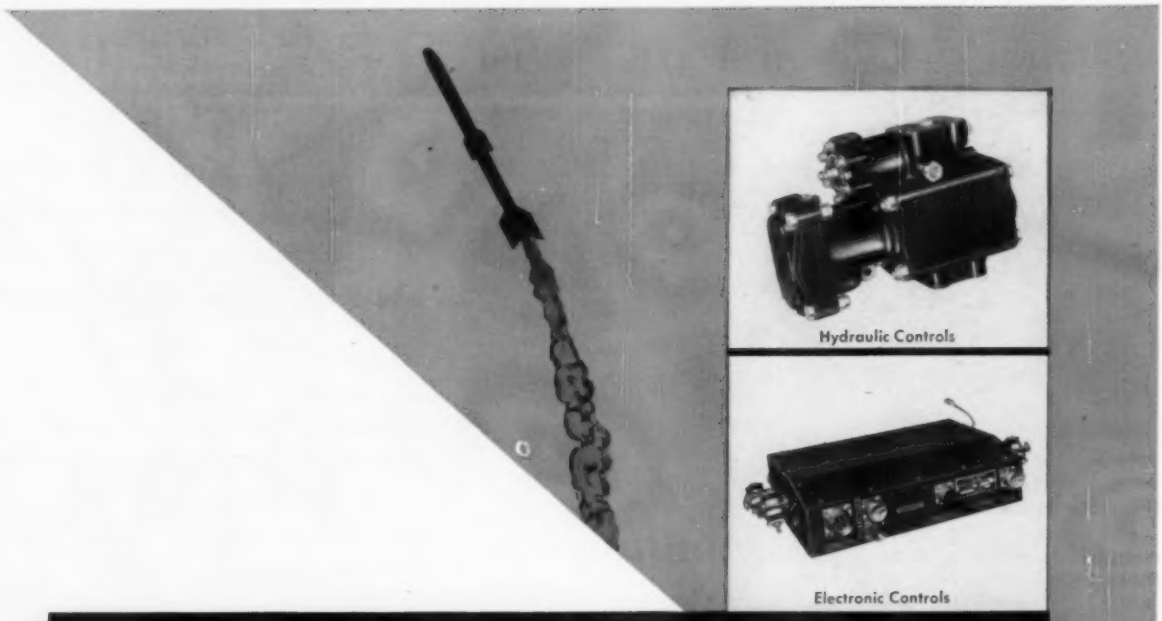

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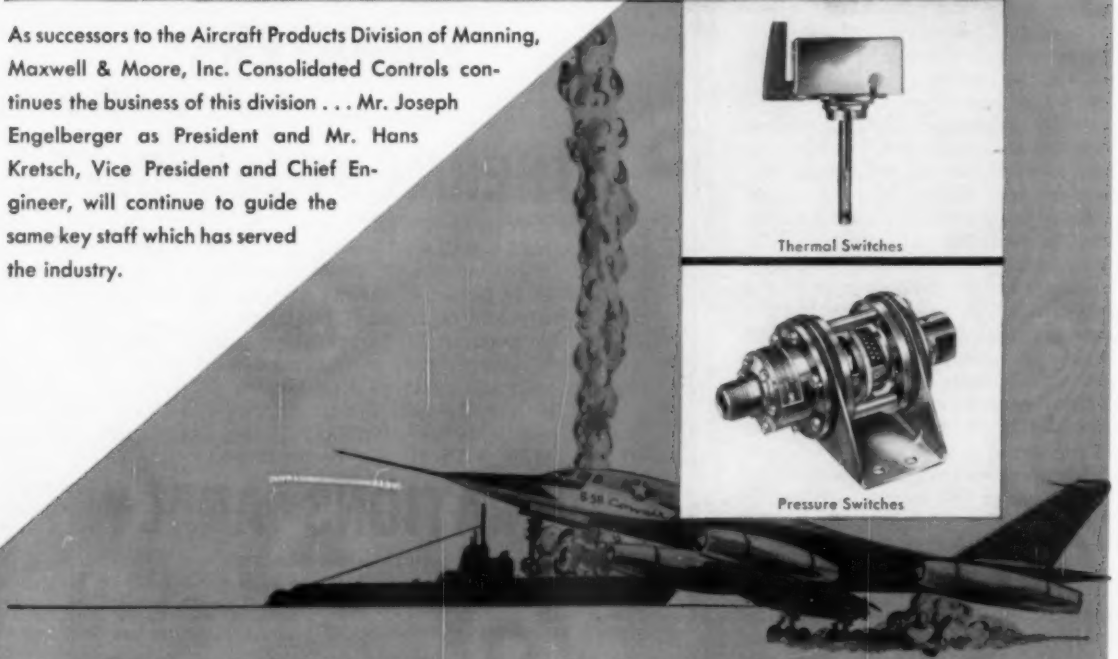

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Airpower's Role in Middle East Subordinate to Ground Forces

Beirut—Despite the war scare, political tension and the increased East-West competition in the Middle East, airpower in the countries of the area in 1957 has not made significant strides to keep pace with the stepped-up cold war.

There were few significant additions to the air forces of the area, either from West or East. In all the Arab countries, airpower's role in national defense continues to remain secondary and subordinate to ground forces.

There was no research and development and no transport plane, combat plane or missile production in any of the Middle Eastern countries.

Strongest air force in the Arab area, as to size, training and experience, is probably that of Egypt, which celebrated the silver jubilee of its air force last December.

During 1957, Egypt is said to have replaced all the MiGs it lost during the Suez fighting through new shipments from the Soviet Union. Thus, the air force size remains around 400, including transports and trainers.

Egyptian MiGs

Although Egypt still has British Meteor and Vampire jet fighters bought from Britain before the arms deal with the Soviet Union, these are becoming less and less operational.

The bulk of the combat force is Russian—MiG-15, and MiG-17 jet fighters and Ilyushin-28 jet bombers.

In addition to Harvard and Chipmunk trainers, Egypt has also acquired Zlin trainers from Czechoslovakia and Yak fighter-trainers from the Soviet Union. Government military factories have assembled from European parts several trainers of the "Gomhouriya" type.

Troop transports of the EAF are made up of C-46s and C-47s.

No information is available of future trends, but the likelihood is there will be no new significant additions to equipment this year if there is no emergency.

Syria has a total operational jet power of 50. These are mostly Russian-acquired MiG-15s and MiG-17s and a few Ilyushin-28s. (Neither Syria nor Egypt are believed to have acquired the MiG-19, despite press reports).

Syria is also known to have 12 Vampires and an unspecified number of non-operational Spitfires. A few weeks ago, the Soviet Union made a gift of three Ilyushin 14 transports to the Syrian government. Syria is also known to have Harvards and Chipmunks and non-operational Fiats, dating from the Palestine war in 1948.

With the announcement in February of the union of Egypt and Syria into a "United Arab Republic," the air forces of these two anti-Baghdad Pact states are expected to merge late this year.

An Egyptian will be commanding the combined new service.

The other anti-Western Arab state in the Middle East—the Kingdom of Yemen in South Arabia—has no combat planes, although it receives Soviet military aid and is closely allied to Egypt and Syria. The King, Imam Ahmed, privately owns several transports.

Two newly independent Arab states in Africa—Libya (where the U.S. has the Wheelus air base) and the Sudan—also have no combat air force. The Sudan recently acquired British-made trainers, but has turned down Soviet offers of MiG-15s.

With the exception of Iraq, the only Arab member of a Western alliance—the Baghdad Pact—the other Arab countries have only embryonic air forces.

Iraq, Jordan, and Lebanon are entirely British equipped and the first two are British trained. Saudi Arabia is dependent on cooperation with the U. S. in equipment and training, strictly on a cash and carry basis.

Lebanon has nine Vampires and six Harvards. There were no additions in 1957 but the Lebanese are trying to acquire this year some British Folland Gnat light jet fighters. United States military aid to Lebanon does not yet include air equipment.

Jordan's small British equipped air force, made up of obsolescent fighters (size and type undetermined), is now negotiating to acquire two squadrons of Hawker Hunters.

British Trained

Iraq, a member of the Baghdad Pact, cooperates with the U. S. and Britain in the military committee of that pact. Its British-trained Air Force, equipped with Meteors and Vampires (mostly), acquired five Hawker Hunters during 1957.

Saudi Arabia has no combat equipment except for six to 10 F-86s which were formerly operational in France and were bought by the Saudi government from the U. S.

In addition, Saudi Arabia has purchased six to 10 T-33 trainers and an unspecified number of T-34s. Saudi recently purchased six twin-engine cargo planes.

Saudi air students are being trained by the USAF both at the Dharan airbase and in the U. S.

Swiss Replacing Combat Fleet

Half of Switzerland's aging fleet of 500 combat airplanes is due for replacement in the next few years.

First of the orders for new equipment has just been concluded with Swiss government approval of the purchase of 100 Hawker Hunter F.6 fighter-bombers replacing the same number of USAF-surplus North American Mustangs.

In addition to these now-obsolete Mustangs, the Swiss operate about 175 de Havilland Vampires and 250 DH Vampires built here under license.

First batch of Vampires is due for replacement next, and around that need has grown one of the biggest collections of criticism, charges and propaganda seen in this country.

Vampire Replacement

The question is whether or not the Swiss-designed FFA P.16 ground support aircraft, developed first by the Eidgenössische Flugzeugwerke (Federal Aircraft Factory) and later turned over to the Flug- and Fahrzeugwerke A.G. (FFA), should be the Vampire replacement.

So far development and testing of this aircraft has cost the Swiss taxpayers about 60 million francs (about $15 million). A third of this went for design and manufacture of the first two prototypes, another third on a test series of four airplanes and the rest on preliminary work for eventually putting the plane into quantity production.

The FFA is now facing outspoken charges in public print of having misrepresented facts and figures relating to the P.16's performance in a publicity campaign launched to influence parliament in its favor.

The president of Avia, an organization of Swiss air force officers, was quoted recently as saying that ". . . this firm (FFA), through deliberately giving wrong dates of delivery, is continuously joking with the credulity of the public and of Swiss military pilots." The pilots themselves are convinced that the P.16—which some of them call the "Submarine"—will soon be outdated and certainly obsolete by the time delivery can start to the Swiss air force, probably not before 1962.

Whether an order will be placed for

● SWITZERLAND

100 airplanes of this type is to be debated in parliament this month.

One argument in favor of buying this aircraft is its suitability for ground support work, the primary task of the Swiss Flugwaffe. Other advantages cited are its heavier armament, increased load-carrying capability and approximately 50% more fuel capacity compared to the Hunter.

The industry also argues that the decision for or against the P.16 will mean life or death to the Swiss aircraft industry as a whole.

But Switzerland's aircraft industry is very small, employing about 1,000 workers.

Including all the various firms who either manufacture parts, or equip or maintain aircraft, the figure is about 3,500.

In contrast, the Swiss machine tool industry—the country's largest employer—accounts for about 250,000. There is essentially no unemployment in this country, and some argue that the unemployed aircraft technicians would not be unemployed for long.

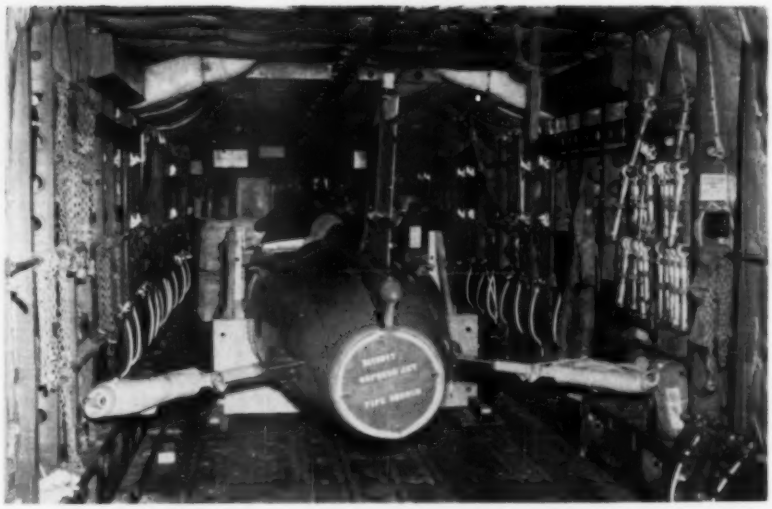
Only four major firms are concerned with the manufacture of aircraft:

• **Flug- und Fahrzeugwerke A.G.,** Altenrhein, which originated in 1926 as a branch of the Dornier-Werke and turned out the famous DO-X flying-boat. During the war years FFA worked exclusively on Swiss army contracts producing, in addition to a large quantity of spare parts, such aircraft as the Morane, the Swiss-designed C.36 and the Messerschmitt 109. FFA is chiefly responsible for the P.16 now under discussion.

• **Pilatus-Flugzeugwerke A.G.,** Stans, a postwar venture working largely on overhaul and maintenance of both civil and military aircraft. In 1943 it developed and produced the P2 trainer for the Swiss air force, two consecutive models of which were put into service.

• **Gebrueder Sulzer, Winterthur,** who makes power plants, largely under license.

• **Eidgenössisches Flugzeugwerk** (Federal Aircraft Factory), Emmen, which is the government research, establishment and where assembly and flight tests are carried out.



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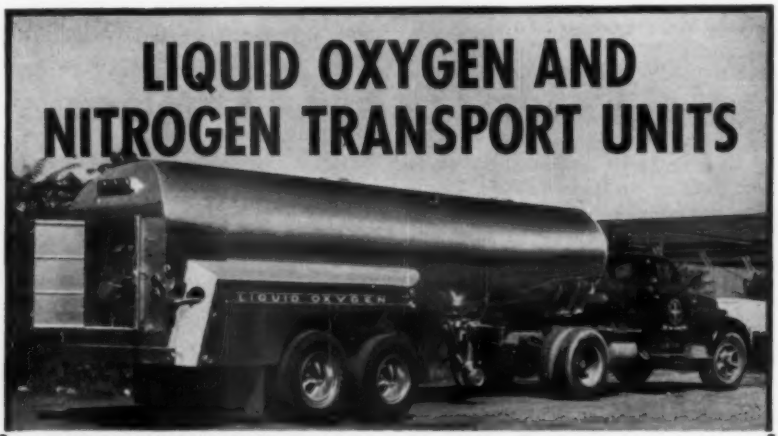

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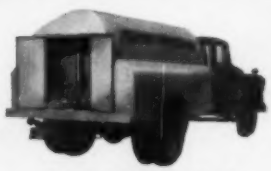

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Defense Plans Moon, Satelloid Request

Washington—Congress probably will be asked within the near future to appropriate funds to initiate projects aimed at getting man into space and a rocket to impact on the Moon.

Defense Secretary Neil McElroy told the Senate Preparedness Subcommittee last week that these proposals are among the projects the Joint Chiefs of Staff is now considering for inclusion as top priority projects in a 1959 supplemental budget request. Recommendations may be ready for Congress by late March. McElroy said it would represent a "considerable increase" over the Fiscal 1958 supplemental.

Requests to extend Boeing B-52 production probably also will be asked.

McElroy said both the Army and Air Force will participate in the program to "shoot the Moon." Program for putting a man into space, McElroy said, may be the next step after development of the North American X-15 rocket research aircraft.

The subcommittee headed by Sen. Lyndon Johnson (D.-Tex.) asked McElroy to appear last week to report on progress being made on the group's 17 recommendations for putting the nation ahead of Russia in the space weapons race (AW Feb. 3, p. 33). He was asked to return again between April 1 and April 10 for another progress report.

McElroy told the subcommittee that the proposal to place additional orders for B-52 heavy bombers and KC-135 jet tankers will be considered for inclusion in the 1959 supplementary program rather than waiting until fall as planned earlier. Under the present program, B-52 production would end in early 1960.

Gen. Curtis LeMay, Air Force vice chief of staff, has testified before the House Armed Services Committee that the currently programmed B-52 Force for Strategic Air Command—603 aircraft—is not large enough and that the production line should continue at least another year to bring the total up to 783 planes. He added that he believes the proper ratio of the B-52s and the supersonic Convair B-58 should be three B-52s to one B-58. Final decision, however, will depend upon information gained from operational experience with the B-58.

McElroy also reported that proposals from five bidders for rocket engines with 1,000,000 lb. thrust or more are being evaluated and that a contract will be awarded soon. Work on the engine, he said, is now progressing through the preliminary stages and an advanced design competition for such an engine has been initiated by the Air Force.

"If an engine of this thrust should be required before the proposed single chamber engine becomes available," he said, "the requirement can be met by clustering several engines of smaller thrust which the Air Force has in a more advanced stage of development."

He said any future requirements for multi-million pound levels could be achieved by clustering several million pound thrust engines.

Other developments and plans outlined by McElroy include:

• **Office of the Anti-Submarine** Warfare Readiness Executive was established by Navy on Jan. 14 for the specific purpose of providing the chief of naval operations special assistance in the planning and direction of anti-submarine warfare readiness programs.

• **Atlas ICBM production rate** has been accelerated by one-third. Acceleration of the Titan ICBM may be included in 1959 supplemental budget requests. Consideration also will be given to increasing orders for the Northrop Snark cruise missile.

• **Improvements in DEW-line radars** and communications will now be funded from Fiscal 1958 appropriations, advancing them by a year.

• **Defense Department** has instructed the military departments to increase the sharing of scientific information with selected allied countries.

• **Plan for reorganization** of the Defense Department will be submitted by McElroy to the President and Congress within the near future.

• **Establishment of the Advanced** Research Projects Agency designed to speed decisions, simplify administration and control and reduce confusion in such programs as satellites.

Speed Blisters X-7

Lockheed X-7 ramjet test vehicle reached speed high enough to blister paint in flight at Alamogordo, N. M. Unspecified record speed claimed by Lockheed undoubtedly is same record speed—Mach 3.95—recently claimed for Marquardt ramjet (AW Feb. 3, p. 30).

USAF Urges Broad Space Program Now

Washington—USAF last week warned Congress that "the conquest of space or at least its denial to an enemy is vital to continued U.S. security" and outlined an astronautics program for "the long, grim, difficult struggle" toward this goal.

"We must not lose the race of man to outer space," Lt. Gen. Donald L. Putt, deputy chief for research and development, told the House Armed Services Committee.

"A maximum-effort program must be started" now to "demonstrate manned space flight at the earliest possible date," Putt said.

Manned Satellite Funding

Defense Department now has tentative plans to ask for funds to begin a manned satellite project and a lunar impact project in its Fiscal 1959 supplemental budget request.

Urgency of the situation is indicated by Soviet Russia's probable timetable, Putt told the House Committee. In the next six months, he said, Russia probably will try to put a payload on the Moon, recover satellite payloads—including "an animal and perhaps a human being"—and launch more animal-bearing satellites "at any time."

U.S. should use its existing missile capability to send out interplanetary and lunar probes, make lunar impacts and launch satellites, Putt said. It also should accelerate its boost-glide orbital manned vehicle project, develop a recoverable manned satellite, accelerate nuclear rocket work, study manned space platforms and manned lunar vehicles "and more futuristic space weapons," and accelerate basic and applied research, he said.

Putt Testimony

Putt also testified that:

• **Although there still** is divided opinion on the real significance of a lunar military base, "the Moon is most certainly destined to be the first of the outer worlds to be explored by man" (AW Feb. 10, p. 26).

• **Volume of computer** work on lunar trajectories in this country "probably is somewhat less than the Soviets'" (AW Nov. 25, p. 30).

• **Soviets are clearly well on** the propulsion road to being able to undertake almost any space-flight feat they desire, even with "no rocket capability greater than that used to launch Sputnik II"—including putting "a worthwhile payload on a lunar or interplanetary trajectory."

U.S. Capabilities

On U.S. capabilities, Putt said:

• **More than $50 million** is being spent on the Lockheed WS-117L Pied Piper reconnaissance satellite (AW Oct. 14, p. 26) in Fiscal 1958 and "we expect to spend more than $100 million in Fiscal 1959."

All parts of the program, including ground stations, are "on schedule for a first launch date in the very near future."

• **Approval will be asked soon** to begin developing one and possibly two types of manned orbital test-vehicles. One proposal "of rather unique configuration and characteristics," launched as the final stage of a missile and having both a high-drag and high-lift shape, resulted from a meeting of 150 scientists and engineers invited to Woods Hole, Mass., last summer by USAF and National Academy of Sciences to review Air Force research and development programs. Preliminary wind tunnel tests of a model have been completed and they confirm major design assumptions. Two other proposals are the North American X-15, using Navaho booster as its booster and launched by Douglas Thor and Convair Atlas airframes and guidance systems; and the DYNA-SOAR (dynamic soaring) project.

Putt called the latter "an active project."

• **"First launch for the Moon** would be made this year" if a project were begun "in the next few weeks" to put a radio transmitter and spotter charge on the Moon by using Thor plus Vanguard components.

• **Thor plus other stages** could put in orbit a one-ton-plus satellite. With a slightly modified Thor powerplant and a second stage, it could put considerably larger satellites in orbit.

• **With Atlas as a primary booster** "we can easily have satellite payloads greater than two tons."

• **USAF is developing** four improved auxiliary power sources for use in satellites, "one of which utilizes nuclear energy and another solar energy." Nuclear source is believed to be Project SNAP (Secondary Nuclear Auxiliary Power), at North American Aviation, Inc.

• **"Great emphasis" is being** placed on rapid development of an air-launched ballistic missile. "No major technical breakthrough is necessary," and they would permit "radical reductions in weight" compared to IRBMs. They would extend useful life of the B-52, B-58 and B-70 chemical bomber "far into the astronautics age."

• **Project Rover,** "a very high thrust nuclear rocket," is "now in the very early stages of development."

• **"Extremely large,** high impulse solid propellant units," more easily stored liquid propellants, high energy fuels and additives and "engines of 1,000,000 lb. thrust" also are under "advanced development and study."

• **Entire family** of ballistic research vehicles using for the most part existing components, has been initiated. This is believed to be the BRATS (Ballistic Research And Test Systems) project.

The project offers low cost and flexibility for research work.

Putt said an adequate deterrent force must be maintained and modernized step by step and "we dare not wait and accept only the tremendous scientific advances." He also said "we must devote still more energy and effort toward an early conquest of space," and said "eventually, space superiority will become the primary factor in assurance of world peace."

U. S. Space Needs

Washington—Steps the U.S. should take immediately to "insure a faster rate of scientific progress than the Soviets" in space programs were outlined to Congress last week by USAF Lt. Gen. Donald L. Putt, deputy chief for research and development. General recommendations were:

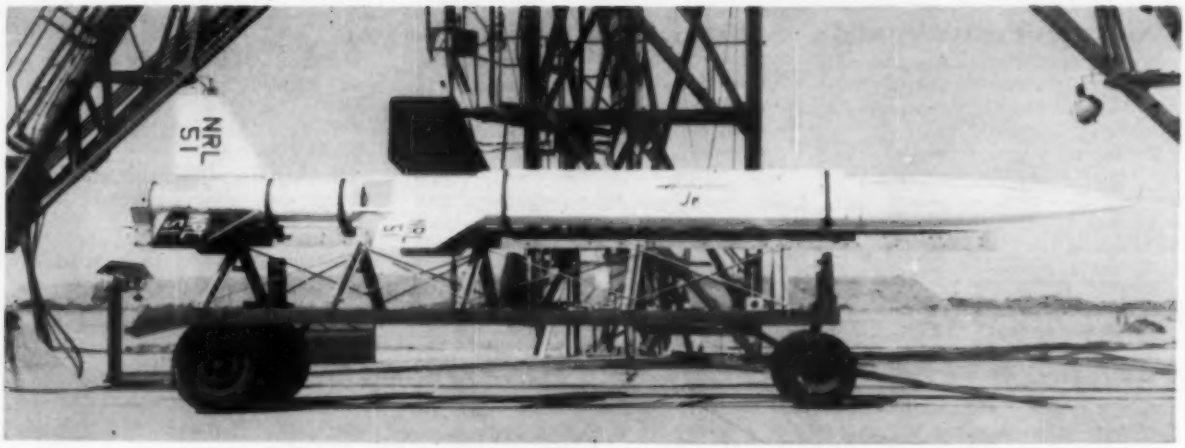
- **"Acceleration of the DYNA-SOAR boost-glide project."**
- **"Utilization of existing missile capability for satellite launchings, lunar probes and impacts and interplanetary outer space investigations."**
- **"Early development of a recoverable manned satellite."**
- **"Acceleration of the nuclear rocket engine project."**
- **"Additional technical feasibility studies of manned space platforms, man-carrying lunar vehicles and other more futuristic space weapons."**
- **"General acceleration of the basic and applied research effort."**

Soviet Space Plans

Washington—Russia probably will attempt four significant accomplishments in the field of space within the next six months, USAF Lt. Gen. Donald L. Putt, deputy chief for research and development, told Congress last week.

They are:

- **"More animal-bearing satellites, at any time."**
- **"Recovery of a satellite payload."**
- **"Recovery of an animal and, perhaps a human being."**
- **"A lunar impact."**



Navy Flight-Tests Aerobee Junior Research Rocket

Aerobee Junior research rocket is a liquid-propellant rocket with a solid-propellant booster privately developed by Aerojet-General Corp. Rocket, designated Aerobee 100, was delivered to Naval Research Laboratory for flight evaluation at Naval Ordnance Missiles Flight Test Facilities at White Sands Proving Grounds, N. M. In flight test, rocket attained altitude of 60 mi., Aerojet-General said.

U.S. Weighs British Engine Offer

Washington—Air Force and Navy are studying a British government proposal that they buy military aircraft engines direct from the United Kingdom under the same kind of "interdependence" agreement that will put four Thor intermediate ballistic missile squadrons in U.K. countries beginning next December.

Request was sent through Secretary of State John Foster Dulles to Defense Secretary Neil H. McElroy early in February and is still under study.

State, which completed the missile bases agreement with Britain last week, disqualified itself as a judge of the "technical considerations involved" on aircraft engines but asked Defense to "give careful consideration to the request in the light of the principle of interdependence" expressed last October by President Eisenhower and Britain's Prime Minister Harold Macmillan.

Neither State nor Defense Department nor British firms will say what British engines or companies would be involved. Services are almost certain to oppose the idea regardless of the worth of the engines, because of maintenance and other problems that would be created.

Engines British would like to market for use in Boeing B-52 bombers and KC-135 tankers are the 17,500 lb. thrust Rolls-Royce Conway bypass and the Bristol Olympus, which has a thrust range from 11,000 to 16,000 lb.

The five-year missile pact leaves the firing decision a joint matter for the U.S. and U.K. Control of nuclear warheads remains with the U.S. Australia's Woomera Range might be used for test firings.

Solid-Propelled ICBM

Washington—Air Force is ready to order development of intercontinental ballistic missiles powered by solid propellants.

Maj. Gen. B. A. Schriever, commander of Air Research and Development Command's Ballistic Missile Division, told the House Armed Services Committee last week that techniques and methods for use of solid propellants have been improved to the point where chances for success of such an ICBM program appear promising.

Lt. Gen. Clarence Irvine, USAF deputy chief of staff for materiel, told the committee use of the solid propellants would eliminate the requirement for extensive liquid oxygen and fueling tankage, piping, complicated valving mechanisms and some electronic checkout gear.

Gen. Irvine also said the Air Force is interested in obtaining more Douglas C-133s, which are capable of transporting all the ballistic missiles now being produced, and more Lockheed C-130s. Thus far, only 33 of the C-133s have been ordered.

USAF plans to place one U.S.-trained but British-manned Thor squadron of 15 missiles and 5 back-ups on U.K. soil in December. U.S. will help Britain build bases. One Jupiter squadron will be ready in the same month but will probably go to France.

Air Force Secretary James A. Douglas revealed in testimony released by the House Armed Services Committee that USAF is spending $113 million for Thors and $65 million for support equipment in the remainder of Fiscal 1958, and $161 million plus $91 million in support items in Fiscal 1959.

First production Jupiter is due out of Redstone Arsenal in June. Chrysler Corp. expects to begin producing Jupiters in February of next year.

Thor squadrons require 500 operational personnel plus support personnel, Douglas said. He did not give a Jupiter figure.

Gen. Putt Criticizes Anti-Missile Decision

Washington—Decision to develop Army's Nike-Zeus anti-missile missile system rather than Air Force's competing Wizard system was termed "premature" last week in testimony released by the House Armed Services committee.

Lt. Gen. D. L. Putt, USAF deputy chief of staff for research and development, told the committee that the Wizard program would have had greater flexibility and more capabilities.

Gen. Putt indicated that Nike-Zeus will not have the flexibility to cope with possible countermeasures, while the Wizard could be developed to meet the situation.

He said Air Force had carried out studies and component developments with three different contractor teams and was close to a design decision when Defense Department ordered Nike-Zeus into development.

In a directive issued in January, Defense Secretary Neil H. McElroy ordered the Army to continue development of the Nike-Zeus and USAF to discontinue research and development of the Wizard missile (AW Jan. 27, p. 26). At the same time, Air Force was directed to continue development of

Titan Priority Drops

Washington—Rating of top national priority has been removed from the Air Force-Martin Titan intercontinental ballistio missile program.

Air Force Secretary James Douglas told House Armed Services Committee last week that, when the projects were reviewed in August, it was thought feasible to remove Titan from the top priority which had been granted to all Air Force ballistic missile projects since it is approximately one year behind the Convair Atlas.

Other witnesses testified that the more-sophisticated Titan will be capable of carrying a larger warhead than the Atlas. First flight is scheduled for later this year. Witnesses also testified that $2,600 million has been funded for USAF's ballistic missile program from 1954 to 1958.

the ballistic missile early warning system.

In other testimony, Air Force Secretary James Douglas told the committee Soviet Earth satellites show that:

• **Relatively advanced** state of rocketry, a large, well-controlled propulsion system and reasonably good guidance are possessed by the Soviets.

• **Good evidence** that the Russians have developed an effective intercontinental ballistic missile.

• **An indication of** what the Soviets are beginning to accomplish in scientific and technological fields by channeling their most able youths into mathematics, science, engineering and other technical fields.

Douglas Notes Gain In Sale of Missiles

Santa Monica, Calif.—Dominant trend in a year end financial report issued last week by Douglas Aircraft Co. was down, though total sales stayed over the 1 billion mark.

Net income on sales of $1,091,366,000 was $30,655,000 or $8.28 a share. Comparable figures for 1956 were sales of $1,073,515,000; net income, $33,202,000 or $8.96 a common share. It was the second billion dollar sales year in a row for Douglas.

Release of the report coincided with the sale of a large bloc of Douglas stock—100,000 shares—on the New York Stock Exchange at a price of $55.50 a share. The seller was not an "insider," that is, an officer of or director of the company. After declining for the last two weeks, prices for Douglas shares rebounded after the sale.

Other trends from the report:

• **Swing to missiles.** Douglas missile sales rose from 16% to 27% of the military total, compared with 1956 and the 1957 missile sales dollar total, $199 million, was 42% more than the 1956 figure. Missile backlog now is 31% of the company's military backlog.

• **Increasing importance** of commercial business. More than 51% of unfilled orders at Douglas are for commercial aircraft. How pronounced this trend is was shown by chart which showed military share of Douglas backlog declining from approximately 90% to less than 50%. Total backlog at the end of 1957 was $1,804 million, a decline from $2,209 million in 1956.

• **Reappearance** of borrowing from banks. Douglas has been free of bank loans since 1953, but used $55 million of a $150 million line of bank credit extended last year. Drain on cash balances was blamed by Douglas on DC-8 development costs, and on Defense Department fiscal changes including further reduction in percentage of progress payments on fixed price contracts and a substantial reduction in the amount of current reimbursement in cost plus fixed fee contracts.

Increased Utilization Pushed by MATS

Washington—Military Air Transport Service anticipates an annual $300 million volume of business to finance its operations, according to Brig. Gen. Albert Wilson, MATS Deputy Chief of Staff.

Gen. Wilson outlined MATS plan for increased utilization which is "being pushed to the maximum" in testimony to a House Government Operations subcommittee:

• **Increase average flight time** of aircraft from three to six hours a day;

• **Cutback overhaul time on aircraft** from the present 60 to 70 days to 15 to 25 days;

• **Obtain cargo handling equipment** to reduce loading and unloading time. He said MATS is now considering bids from 14 contractors.

Gen. Wilson said the increased utilization will mean that MATS will have less expansion capability for mobilization. "It means we could rely more on commercial aircraft reserve for mobilization airlift—if they only had the proper type of aircraft," he said.

Even with the phase in of Douglas C-133 cargo transports and the phase-out of obsolescent types MATS "will still lack capability for mobilization," Gen. Wilson said.

The shipment of missiles abroad, he pointed out, now confronts MATS "with a terrific problem."

J52 for Hound Dog

Washington—Primary power source for the North American WS-132 Hound Dog air-to-ground electronic countermeasures missile will be the Pratt & Whitney J52 turbojet engine rated at 7,500 lb. thrust. The supersonic Hound Dog is being developed for use from Boeing B-52.

Senate Approves Capital Earnings Bill

Washington—Senate passage of legislation authorizing subsidized carriers to set aside capital earnings from equipment sales for the purchase of new equipment apparently assures final enactment.

The House passed the measure during the last session. Senate opposition was led by Sen. Frank Lausche (D.-Ohio) and Sen. John Williams (R.-Del.). A Lausche move to substitute a system of loans for airline equipment purchases, repayable within six years, was defeated 70 to 14.

Differences between the House and Senate versions to be ironed out by a joint conference committee are:

• **Senate measure** is retroactive to April 6, 1956. House measure would become effective on the date of enactment.

• **Senate bill provides** that capital losses also shall be set aside and not considered in the determination of subsidies. The House measure provides for only the set aside of capital gains.

In Senate debate, opponents estimated the total set-aside of airline capital gains under the legislation at $67 million; its proponents put it at $47 million.

Comptroller General is opposed to enactment. But the support of the Secretary of Commerce and Director of the Bureau of Budget indicate Presidential approval.

ALPA-Western Strike Remains Unsettled

Air Line Pilot's Assn. strike against Western Air Lines remained unsettled last week. Efforts to settle a contract dispute failed and the strike began Feb. 21.

A government proposal to settle some issues and provide for arbitration of others was rejected by the airline management. ALPA had accepted it.

Dispute between ALPA and Flight Engineers' International Assn. as to whether jet transport flight engineers shall be mechanic-qualified or pilot-qualified has been an issue in the ALPA-Western negotiations, but is not involved in the strike, according to the National Mediation Board.

NACA Budget Request Trimmed by House

Washington—House last week cut $2.3 million from a request by National Advisory Committee for Aeronautics for funds for urgent projects and clamped a ban on additional NACA personnel.

NACA's request of $11.8 million provided for a personnel increase from 7,935 to 8,400, as a step toward the 9,000 provided in the Fiscal 1959 budget. The House cut this to $9.5 million (AW Feb. 24, p. 32). A move by Rep. Sidney Yates (D.-Ill.) to remove the ban on additional employment was defeated on an unrecorded 59 to 74 vote.

News Digest

Lycoming T53 turbine engine will be provided by Army for Navy hydrofoil research ship to be built by Miami Shipbuilding Corp.

Grumman A2F-1, Navy high and low-altitude attack plane, will be powered by a 7,500 lb. thrust Pratt & Whitney J52 turbine engine. Development contract for the two-place carrier-based aircraft was awarded to Grumman Aircraft Engineering Corp. early this year.

Britain and Russia last week signed a bilateral air agreement providing for a direct air route between London and Moscow. Service will begin this summer. British service will be represented by British European Airways which will fly turboprop Viscounts. Soviet-owned airline, Aeroflot, will operate either the Tu-104 turbojet or the Il-18 turboprop transport.

McDonnell Aircraft's F4H Navy jet fighter is nearing flight status. Latest order of $15,956,377 for the twin-jet, all-weather fighter brings contract totals to $167,207,206. Long-range, carrier-based fighter will carry a radar operator.

Ninth Republic F-105 fighter-bomber is at Eielson AFB, Fairbanks, Alaska, for actual Arctic operational tests. Air Force now has 11 of the nuclear-weapons-carrying aircraft undergoing evaluation testing.

North American Aviation's WS-110A intercontinental chemical bomber has been given the Air Force designation B-70. Bomber is now in the preliminary design engineering stage at North American.

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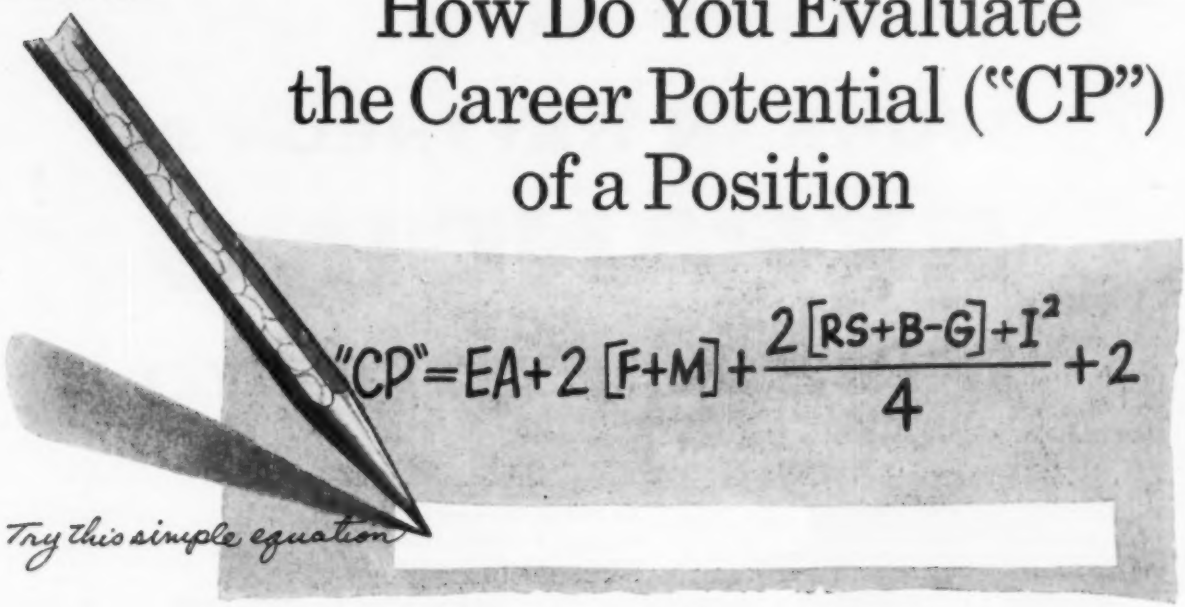

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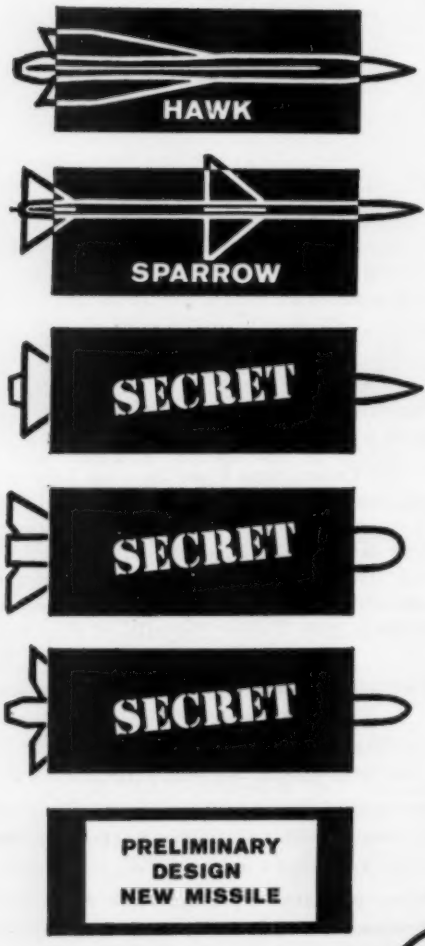

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73	ALL 599	Drive Assy.—Breeze
384	564-2A	Oil Separator—Eclipse
19	753-300—28 V.D.C.	Intervalometer—Rhodes Lewis
22	926-0160	Teletorque Transmitter—Kollsman
100	JR950R—24 V.	Starter
5	T2100-3A	Directional Gyro—Kearfott
172	5103H2-003	Reset Timer—Hayden
20	5911-12B-1A	Flap Position Indicator—Bendix
2	RG7021-A4	Fuel Power Unit—Minn. Honeywell
508	C7400	Radium Head
2300	A7979	Filter—Adel
4	12076-1A	Amplifier—Eclipse-Pioneer
8	16801A	Hyd. Transmission—Vickers
59	42302	Thermal Timer—Ulanet
10	FCF25613	Tank—U. S. Rubber
50	31551-006-05	Shafting—Lear
17	D106018-1	Air Flow Regulator—Airesearch
125	104244-4—Type C6	Fuel Strainer—Aero
34	146102	Power Brake—Bendix

150 ENGINES
R 2600—20 WRIGHT

Quantity	Part No.	Description
8	902009	Reducer—Union Switch & Signal
46	C2	Fuel Strainer—Aero
1292	AW2-65B—2000 lbs.	Pressure Gauge
52	42472	Engine Mounts
199	48350	Intermediate Rear Crankcase & Blower Assy.—P.W.
1400	48360	Bearing—P.W.
75	48363	Bearing—P.W.
438	33786-2	Thermocouple—Edison
473	U401937	Fuel Cocks
178	870491—5#	Air Bottle—Kidde
124	870979—5#	Air Bottle—Kidde
62	CF10FA-540	Vibrator—Globe
7	G16A2CA21	Pressuretrol—Allen
97	6041-146A	Relay—C-H
442	G31502A	Relay—Guardian
295	A3325	Relay—C. P. Clare
116	LLX7307	Transformer—Raytheon
392	B5699	Transformer—U.T.C.
22	BX379	Transformer—Balto Transformer
49	CG-40	Choke—U.T.C.
18	77C5	Carb. Air Temp. Indicator—Lewis
16	77C4	Oil Temp. Indicator—Lewis
5	AN5544-3	Tachometer Generator—G.E.
148	8TJ9-PXK-41	Position Transmitter—G.E.
47	254BK-6-052	Differential Pressure Guage—Kollsman
67	840-21Z-2	D.C. Voltmeter—Weston
149	10966A	Dash Unit
600	AN8002-2	Hand Grip
120	4001	Axel
8	BC733D	Receiver—Belmont
30	RA10DB	Receiver—Bendix
23	TA12B	Transmitter—Bendix
40	AN6203-3	Accumulator—Bendix
67	58G927	Ballast Coil—G.E.
23	0655D	Oxygen Regulator—Aro
300	982585	Valve—Kidde
99	M5188	Jack Box—Bendix
26	MR16D	Range Filter—Bendix

VALVES

Quantity	Part No.	Description
207	AV1-B1174	Electromagnetic Shut Off—General Controls
233	1265-900	Hyd. Pressure Relief—Airex
95	525-FG¼	Anti-icing—Parker
110	PL4-843-54	Check—Parker
140	SP4-2746-76	Restrictor—Parker
2	4140-11¼	Selector—Parker
52	LGA-10FB	Iris
20	146575—0-1500 PSI	Power Brake—Bendix
232	1V40-210	Iris
1765	73A01	Throttling—for metering vacuum on Turn & Bank Indicators
8	AA37001	Vickers
2310	D506	Servo Control—Airex
77	612-3A	Safety Relief
130	612-4A	Safety Relief
120	709-GG6-6D	
33	747A	Interlock—Rhodes Lewis
33	HQA1064Y	Manual Shut Off—Hydroaire
555	SK1213-108	Oxygen
1578	K1593-6D	Plug
170	2001	Relief—Victor
13	HC2099-M3	Sequence—Air Associates
23	2432-2	Fuel Selector—Bendix
210	6552-2	Whittaker
126	D9607	Control—Adel
140	D9530-2	Hydraulic—Adel
16	AA11435	Vickers
19	AA14503	Vickers
54	AA14542	Regulator—Vickers
10	17589-2	Airesearch
145	35801-3	Shut Off—Koehler
17	92980	Airesearch
28	982051	Kidde
8	404503	4 Way Hyd. Selector—Bendix
340	AN6207-8	
567	AN6207-12	
131	AN6209-8	
140	AN6209-4D	

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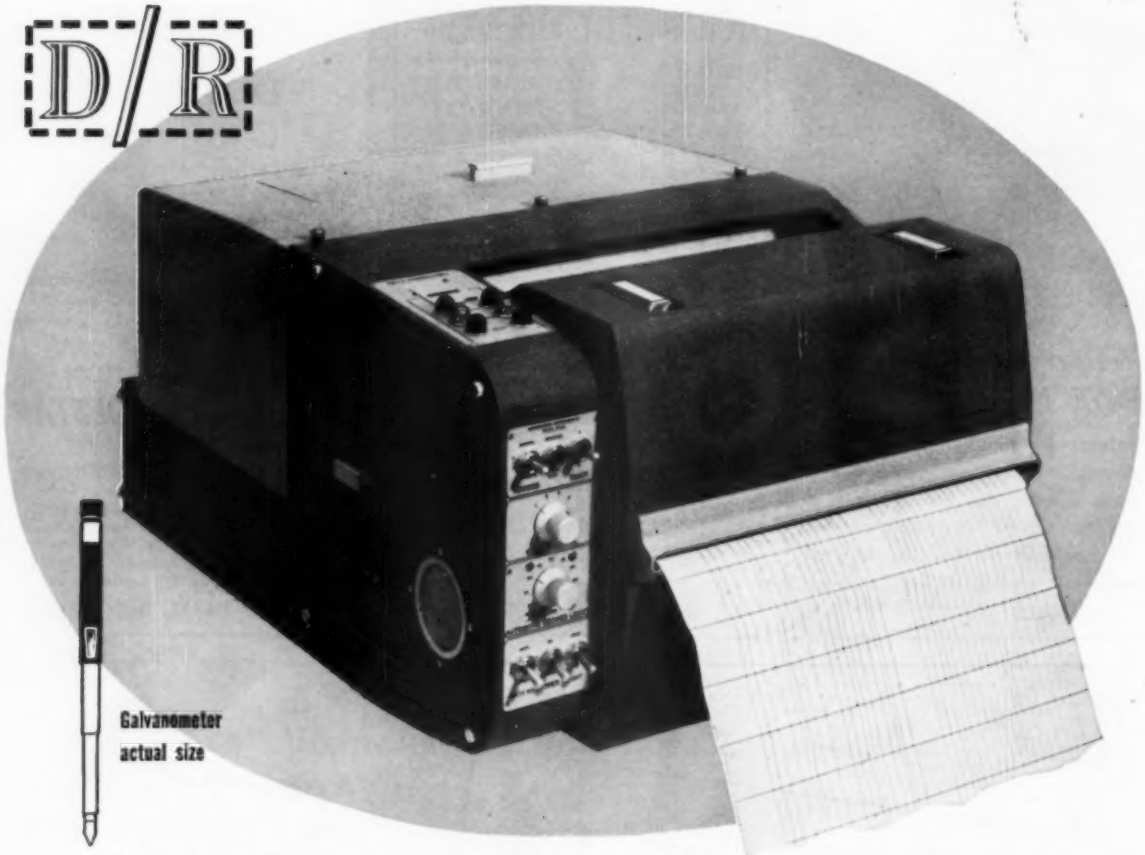

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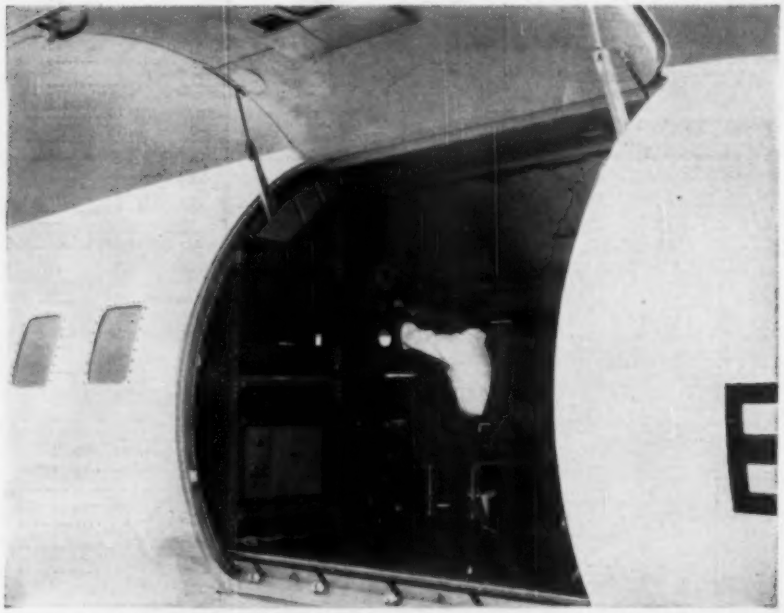

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